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FORT MONMOUTH PROCUREMENT OFFICE
FORT MONMOUTH, NEW JERSEY

MICROMINIATURIZED PACKAGING OF
2N384 and 2N697

Final Report

1 October 1960 - 1 February 1962

**Contract No. DA-36-039-sc-85377
Req. No. 40704-PM-60-93-93**

**SYLVANIA SEMICONDUCTOR DIVISION
WOBURN, MASSACHUSETTS**

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A B S T R A C T

The purpose of this contract was to mount existing germanium drift field and silicon mesa transistor junction structures in an existing welded hermetically sealed miniature "pancake" package by making necessary part modifications and developing required assembly procedures. During the period of the contract the package diameter was reduced from 0.265" max. to 0.250" max. Package height is 0.072" max. The objective electrical specifications are MIL-S-19500/27A (2N384) and MIL-S-19500/99A (2N696-697)

Design changes were made in the drift field transistor junction - base tab assembly and in the transistor header. A welded connection between base tab and base header lead was required to meet objective shock test requirements. Samples meeting the objective specifications were made, evaluated, and delivered.

The silicon mesa transistor junction structure required no modification. A molybdenum pedestal was added to the header for this device and associated material, brazing, and plating problems were solved. Samples meeting the objective specification were made, evaluated, and delivered.

The final packaged devices demonstrated excellent hermetic sealing by readily passing Radiflo leak test with 98% having leak rates less than -1×10^{-11} std. cc/second.

PUBLICATIONS, LECTURES, REPORTS AND CONFERENCES

- A. A meeting was held at Fort Monmouth on October 17, 1960 between representatives of Sylvania, RCA, and the Signal Corps for the purpose of discussing package dimensions. Sylvania agreed to investigate the feasibility of reducing the maximum package diameter from 0.265" to 0.250". Experimental parts to the smaller dimension were not available during this quarter.
- B. A meeting was held at USASRDL on 21 February 1961 attended by representatives of USASRDL, USASSA, and Sylvania. A modification to the contract was agreed to in which the maximum O. D. of the transistor to be developed as a result of this contract was reduced from 0.265" to 0.250". The first devices to the new dimension were scheduled for delivery to the Signal Corps 1 June 1961.
- C. Meetings were held with Mr. Milton Tobman of USASRDL at Woburn on May 24, 1961 and on June 20, 1961 for the purpose of reviewing progress.

TASK I

PURPOSE

- A.** The purpose of this Task is to modify an existing pancake package and an existing internal device structure to develop a transistor 0.072" maximum height and 0.265" maximum diameter having as the objective specification the military 2N384 specification MIL-S-19500/27A. Maximum diameter was reduced during the course of the contract to 0.250".
- B.** To establish assembly techniques.
- C.** To fabricate and submit samples of these devices for approval and standardization.

I. 1 Analysis of Task

Figures A-1 and A-2 (Appendix A) show package and alloy assembly status at initiation of contract. Figure A-1 is the package (header) drawing. Figure A-2 is the drawing of the alloy assembly which was being manufactured, having the electrical characteristics of MIL-S-19500/27A. The dimensions of the assembly obviously far exceeded the maximum space available in the package, therefore the principal task was to reduce the geometric outline of this device without impairing its electrical characteristics.

I. 2 Dimensional Design (Alloy Assembly Only)

This was undertaken in two stages; redesign of a base tab to fit the package and redesign of the alloyed pellet to fit these new base tabs.

I. 2. 1 Base Tab (Geometrical Reduction of)

The Figures A-3 and A-4, Appendix A, are given to illustrate the various designs considered for the base tab. Figure A-4 was selected as the most practical of the group to manufacture and jig; the latter being necessary for subsequent operations. A radius which is equal to the radius of the lead wires of the package header was put on one side of the base tab to make the accomplishment of lead positioning easier. The base metal, nickel, was not changed from what was already in use. Figure A-5, Appendix A, is a manufacturing drawing of Figure A-4, the base tab selected to begin the development program.

Figure A-6, Appendix A, is the final version of the base tab used in the actual production of the 275 development models which were assembled during the third quarter, and used as the official sample group. These devices were submitted for evaluation to the objective specification MIL-S-19500/27A. Contract Item 1(e), 150 development models, were shipped 31 May 1961 from this group.

The basic difference between figures A-5 and A-6 is that the "bullet nose", of Figure A-5 is removed. The reason is discussed in Section 3. 0.

I. 2. 2 Germanium Pellet

The germanium pellet to be used could have taken any number of different geometries such as square, rectangular, or round. The round pellet was chosen initially but was not absolutely necessary. The most influential guide in this decision was the belief that round cavities in alloying fixtures could be made more accurately with ease than any other shape.

The diameter of the round pellet was, when completely processed, equal to approximately fifty-four mils -- the maximum diameter of the base tab. These round pellets were used through the first and second quarter, but at the beginning of the third quarter were changed to a thirty-eight mil by thirty-eight mil square. This change came about as a result of the production facilities capability of reproducing more accurately the square pellet as opposed to the development facilities capability to reproduce round pellets. The round cavities of the alloying fixtures were not affected by this change since the diagonal of the square is slightly less than fifty-four mils.

I. 3 Development of Assembly Procedures

I. 3. 1 Foreword:

The purpose of this task was to take an existing alloyed assembly, the 2N384, and an existing package design, the pancake package Figure A-1, Appendix A, and develop techniques which would enable the manufacturer to produce the 2N384 device in the pancake package. These two parts, package and subassembly, were not developed as a part of this contract and their development prior to the contract is therefore not reported herein.

I. 3. 2 Internal Assembly: Lead Attachment to Alloyed Subassemblies

The arrangement of the alloyed subassembly in the package header during the first two (2) quarters made necessary the attaching of a collector connecting wire before mounting the unit on the header. Figure A-7, Appendix A, illustrates this point and the general internal construction for this period. A sample lot of devices manufactured as described above was submitted for evaluation. The results of testing to MIL-S-19500/27A Groups A and B are tabulated in Table I. All tests were passed except for the shock test. The nine (9) units which failed Group B, Subgroup 3 (500 G, one millisecond shock) were opened and examined. It was determined from this examination that all of these units had been torn loose at the point where the base tab and internal base lead were connected by solder. To eliminate this mode of failure, an alternate method using welded construction was investigated.

Along with the advent of this new assembly approach, an agreement had been reached which brought about a change in the maximum package diameter from .265" to .250". A summation of the task ahead at this particular point is as follows:

1. Solve the shock problem.
2. Modify tools, jigs, fixtures, process to accomodate the new 0.250" diameter package.

Table 1 GROUP A INSPECTION

Examination or Test	Conditions	Symbol	Limits Min	Limits Max	Unit	Sample Size	Number Failures	Number Pass	Notes
<u>Subgroup 1</u> Visual and mechanical examination						100	Zero	All	
<u>Subgroup 2</u>									
Collector cutoff current (dc), open emitter	$VCBO = -12$ vdc $IE = 0$	$ICBO$	-12	uA/dc	100	Zero	All		
Collector cutoff current (dc), open base	$VCEO = -20$ vdc $IB = 0$	$ICEO$	-1	mA/dc					
Collector saturation current	$VCB = 2.5$ vdc $IE = 0$	IS	-8	uA/dc					
Small-signal Short-circuit forward-current transfer ratio.	$f = 1$ kc	h_{FE}	20	175					
<u>Subgroup 3</u>									
Collector cutoff current (dc), open emitter	$VCBO = -40$ vdc $IE = 0$	$ICBO$	-50	uA/dc	100	Zero	All		
Emitter cutoff current (dc), open collector	$VEBO = -0.5$ vdc $IC = 0$	$IEBO$	-12	uA/dc					
<u>Subgroup 4</u>									
Noise figure	$f = 50$ mc $RG = 30 \Omega$ $RL = 2000\Omega$	NF	10	db	100	Zero	All		
Output capacitance	$VCB = -12$ vdc $IE = 0$	C_{ob}	3	uuf					
Transducer Gain	$f = 50$ mc $RG = 30\Omega$ $RL = 2000\Omega$		15	db					

Table 1 (cont'd) GROUP A INSPECTION

Examination or Test	Conditions	Symbol	Limits Min	Limits Max	Unit	Sample Size	Number Failures	Number Pass	Notes
<u>SUPERGROUP 5</u>									
Transducer gain	$f = 50$ mc $R_G = 30\Omega$ $R_L = 2000\Omega$ $V_{CB} = -4$ vdc $I_E = +1.5$ mAdc		13		db	100	Zero	All	
<u>SUPERGROUP 6</u>									
Thermal Resistance		θ_{J-A}				$^{\circ}C/mW$	15	Zero	All

Note No. 1 - The noise figure measurements were made at 12.5 mc.

GROUP B INSPECTION				
<u>SUPERGROUP 1</u>				
Physical dimensions				No. 2
<u>SUPERGROUP 2</u>				
Soldering	5 cycles;			14
Temperature cycling	$T = +95^{\circ} +50^{\circ}$ $-0^{\circ} -0^{\circ}$			
Thermal shock	$T = +95^{\circ} +50^{\circ}$ $-0^{\circ} -0^{\circ}$ and			
(glass strain)	$0^{\circ} \pm 20^{\circ} C$			
Moisture resistance				
End points:	$V_{CBO} = -40$ vdc			
Collector cutoff current	$I_CBO = 0$			
(dc), open emitter	$I = 1mA$			
Small-signal short				
Circuit forward-current				
transfer ratio	h_{fe}			
		15	1	
		15	Zero	All
			-75	uAdc
				15

Table 1 (Cont'd) GROUP B INSPECTION

Examination or Test	Conditions	Symbol	Limit Min	Unit	Sample Size	Number Failures	Number Passes	Notes
<u>SHOCK</u>	<u>SUBGROUP 3</u>	500 G t = 1 nsec; 5 blows each in orientations X_1 , Y_1 , Y_2 , and Z_1 (total of 20 blows)			15	9	6	
		5000 G 10 G 100 to 1000 cps 10 G						All
		Constant acceleration Vibration fatigue Vibration, variable frequency End points: (Same as for Sub- group 2)						Zero
	<u>SUBGROUP 4</u> Lead T_4H_8				15			All
	<u>SUBGROUP 5</u>	Barometric pressure, reduced (altitude operation).	Pressure = 15 mm mercury VCBO = -40 Vdc IE = 0 ICBO = -75 T_4H_8 de- max t = 60 seconds		15			All
		Salt atmosphere (cor- rosion) End points: (Same as for Sub- group 2).						

Table 1 (Cont'd) GROUP B INSPECTION

Examination or Test	Conditions	Symbol	Limits	Unit	Sample Size	Number Failures	Number Pass	Notes
<u>SUBGROUP 6</u> Storage Life	$T_{stg} = +100^{\circ} -30^{\circ} C$				15	Zero	All	
End points: Collector cutoff current (dc), open Small - signal short-circuit forward-current transfer ratio	$VCBO = -40 Vdc$ $IE = 0$	$ICBO$ h_{fe}	-100 uAdc					
<u>SUBGROUP 7</u> Operation life	$T_A = +25^{\circ} \pm 3^{\circ} C$ $PC = 100 -12 mW$				15	Zero	All	
End points: (Same as for Subgroup 6)								

Note No. 2 - One lead diameter too thick.

3. Prepare, evaluate and submit 150 development models in the 0.250" diameter package.

I. 3. 2. 1 Base Tab Welding

The shock problem was solved by substituting base tab welding for soldering. The header design was modified to produce a longer header base lead for lap welding and to reduce the final package diameter to 0.250" maximum. Drawings of the modified header and the tools developed to flatten, weld and bend the base header lead are given in Appendix B.

The steps followed in shaping the base header lead, welding, and bending are illustrated in Figures B-1, B-2, B-3, and B-4 of Appendix B.

Samples were made using both the welded and soldered construction during the same period. These samples were subjected to the shock, constant acceleration and vibration fatigue tests. The results of this experiment are given in Table II, which follows, and clearly demonstrates the efficacy of the weld construction. In this experiment, the twenty (20) soldered units had fewer failures (3) than the original test sample of fifteen (15) which had nine (9) failures as previously shown in Table I. The conclusions drawn are that the soldering technique is very operator dependent and that welding is definitely superior.

I. 3. 2. 2 Assembly Process Specifications

Process specifications describing the assembly method developed are given in Appendix C.

Two possible techniques for attaching leads to the alloyed dots were investigated. The first required the use of a soldering iron, organic flux, and solder. The second approach involved the use of a hydrogen atmosphere conveyor type furnace and graphite jigs to hold alloyed assemblies and lead wires. The latter approach was considered possible because of good emitter and collector dot concentricity.

Attempts to use the furnace technique were discontinued after a mechanical yield of thirty percent was achieved. The reason for abandoning this method was because of the

TABLE II

COMPARISON OF SOLDERED VS WELDED CONSTRUCTION

Construc- tion	Shock			Constant Acceleration			Vibration Fatigue			Notes
	No.	Tstd.	Pass Fail	No.	Tstd.	Pass Fail	No.	Tstd.	Pass Fail	
Soldered (controls)	23	20	3	20	17	3	17	14	3	Note #1
Welded	8	8	0	8	8	0	8	8	0	Note #2
Welded	12	11	1	11	11	0	11	11	0	Note #3

Note #1 The 3 shock failures were opened and examined. This examination revealed that the base tab was torn loose from the internal base lead connection.

Note #2 These units have SR-98 in place of Ecco Bond as the adhesive for attaching the free end of the base tab to the header.

Note #3 The one shock failure was opened and examined, No physical defect could be observed.

very close tolerances required of carbon jigs (boats) to accomplish accurate positioning of the .005" diameter lead wire in the center of the .006" diameter emitter dot. The soldering iron method was therefore used. A description of the internal assembly of the transistor for the first two quarters follows:

1. Connect a .005" diameter, .125" long tin-plated copper wire to the collector dot with the aid of a soldering iron and 63/37 tin/lead solder.
2. Connect "bullet nose" end of tab to the base header lead using a soldering iron, and 63/37 tin/lead solder.
3. Connect a .005" diameter, .100" long tin-plated copper wire to the emitter header lead using a soldering iron and 63/37 tin/lead solder.
4. Connect opposite end of wire used in step 2 to the emitter dot using a soldering iron and 63/37 tin/lead solder.
5. Solder the opposite end of lead attached to the collector dot to the collector header lead.

It is necessary to perform step 2 before step 3. If the order were reversed the wire would detach from the emitter dot. This and keeping the collector wire from contacting the metal portion of the header were considered to be the most difficult operations of the assembly procedure. All other operations were readily accomplished with experienced factory personnel.

TABLE III
GROUP A TEST RESULTS

Parameter-Condition-	Parameter-Condition-				Parameter-Condition-				Parameter-Condition-			
	ICBO VCBO= -12V IE = 0	ICBO VCEO= -20V IB = 0	IS VCB= -1.5V IE = 0	hFE VCBO= -12V IE = 0	ICBO VCEO= -40V IE = 0	ICBO VCEO= -0.5V IE = 0	IS VCB= -12V IE = 0	hFE VCBO= -12V IE = 0	N. F. (1) VCB = -12V mA = 1.5mA f = 12.5 mc	N. F. (2) VCB = -12V IE = 0	IS VCB= -12V IE = 0	hFE VCBO= -12V IE = 0
Limit -	<12 μ A	<1000 μ A	<8 μ A	>20 <175	>20 <50 μ A	<20 <12 μ A	>20 <50 μ A	<12 μ A	<10db	<3pf	>15db	>13db
MAXIMUM	7.6 90%	660.0 280.0	5.8 3.5	155.0 135.0	12.0 7.0	6.8 1.2	5.6 4.2	12.5 11.2	2.8 2.4	21.2 20.1	21.0 19.7	
MEDIAN	2.8 10%	115.0 29.0	2.1 1.2	82.0 43.0	4.2 2.2	0.3 0.2	3.4 2.6	9.5 7.8	2.1 1.8	19.3 18.0	18.4 15.1	
MINIMUM	0.7	12.0	0.5	28.0	1.1	0.1	2.0	6.2	1.7	15.5	13.7	

(1) Measured on the kit used for Device #5; Correlated with the Signal Corps.
 (2) Measured on a kit that is in the development stage and which has not been correlated.

I. 4 Fabrication and Testing Development Models for Delivery

I. 4. 1 Fabrication:

<u>Sub assemblies and Parts</u> - Appendix C	<u>Drawing No.</u>
Header	B31-33127-P119
Alloyed Dice & Base Tab Assembly	TF50-6
Lead Wire	A31-7371-P85
Cap	A31X-33124-P74

Assembly Process Specifications - Appendix C

Tab Welding	TF50-1
Header Adjust	TF50-2
Tab Bend	TF50-3
Pre-Test	TF50-4
Ecco Bond	TF50-5

Using parts and specifications listed above, 275 development models were built in 0.250" diameter packages using welded base tab attachment.

I. 4. 2 Test and Evaluation

The 275 devices were evaluated to the objective specification MIL-S-19500/27A.

I. 4. 2. 1 Group A Tests

Group A test results are tabulated in Table III.

I. 4. 2. 2 Group B Tests

Group B test results are presented in Table IV.

I. 4. 2. 3 Power Dissipation Capability

Dissipation in free 25°C air is approximately 100 mw and in an infinite 25°C heat sink is approximately 300 mw.

I. 4. 2. 4 Summary and Conclusions

Summary: The devices fabricated and submitted met all of the Group A requirements of the objective specification for this task, MIL-S-19500/27A.

The devices were successfully built in a smaller package than the 0.265" maximum diameter required by the original contract: 0.250" maximum diameter.

The final development models passed all Group B requirements of objective specification MIL-S-19500/27A except for Subgroup 3. Four out of a sample of 20 failed Subgroup 3, 2 on 5000 g Constant Acceleration, 1 on 10 g Vibration Fatigue, and 1 on 10 g Variable Frequency Vibration Fatigue. Subsequent investigation revealed improper loading technique and marginal design of the Constant Acceleration test fixture had caused marked deformation of the header-flange area of the failed devices and was the direct cause of their failure. Properly loaded devices did not fail Group B tests.

Conclusion: The Sylvania drift field PNIP junction assembly was successfully modified and mounted in the Sylvania "pancake" package less than 0.072" high and less than 0.250" diameter. The final development models delivered met or exceeded all of the requirements of the objective specification MIL-S-19500/27A.

Test results of Group B, Subgroup 3 were adversely affected by defective jiggling.

Leak testing of the final package by Radiflo showed 1143 units of a test lot of 1164 with leak rates less than 1×10^{-11} std. c. c. /min. None had leak rates greater than 5×10^{-7} std. c. c. /min. Figure 1 is a graph of these results.

TABLE IV
GROUP B INSPECTION

EXAMINATION OR TEST	CONDITIONS	Symbol	Limits	Sample Size	Number Failures	Number Pass	Notes
			Min Max	Unit			
<u>SUBGROUP 1</u> Physical dimensions							
<u>SUBGROUP 2</u>							
Soldering	5 cycles; T = +95° + 5° C -0° C						
Temperature cycling	T = +95° + 5° C -0° C						
Thermal shock (glass strain)	T = +95° + 5° C -0° C 0° ± 2° C						
Moisture resistance							
End points:	V _{CBO} = -40Vdc						
Collector cutoff current (dc), open emitter	I _E = 0						
	f = 1kc						
Small-signal short circuit forward-current transfer ratio							
<u>SUBGROUP 3</u>							
Shock							
	500 G						
	t = 1 msec;						
	5 blows each in						
	orientations X ₁ ,						
	Y ₁ , Y ₂ , and Z ₁						
	(total of 20 blows)						
Constant acceleration	5000 G						
Vibration fatigue	10 G						
Vibration, variable frequency	100 to 1000 cps						
End points:	10 G						
	(Same as for Sub- group 2)						

TABLE IV (Cont'd)
GROUP B INSPECTION

EXAMINATION OR TEST	CONDITIONS	Symbol	Limits Min	Limits Max	Unit	Sample Size	Number Failures	Number Passes	Notes
<u>SUBGROUP 4</u> Lead fatigue						20	0	20	All
<u>SUBGROUP 5</u> Barometric pressure, reduced (altitude operation).	Pressure = 15mm mercury VCBO = -40 Vdc IE = 0 ICBO = -75.7 uAdc, max. t = 60 seconds					20	0	20	All
Salt atmosphere (corrosion) End Points: (Same as for Subgroup 2).						20	0	20	All
<u>SUBGROUP 6</u> Storage life End points: Collector cutoff current (dc), open Small - signal short-circuit forward-current transfer ratio	T _{stg} = +100° ^{+0°} _{-3°} C VCBO = -40 Vdc IE = 0 h _{fe}	ICBO	-100	uAdc		20	0	20	All
<u>SUBGROUP 7</u> Operation life End points: (Same as for Subgroup 6)	T _A = +25° ^{+3°} _{-3°} C P _C = 120 ± 12 mW		15	-100		19	0	19	All

Note 1: One flange diameter .001" over .250" maximum.

Note 2: One ICBO failure on Temperature Cycling.

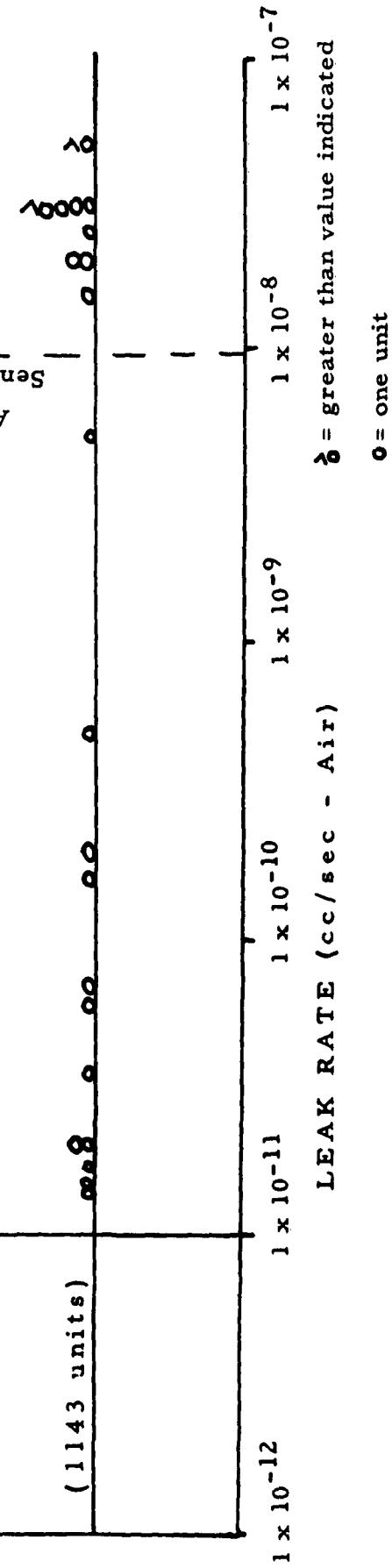
Note 3: Test fixture caused failure recorded. See Section I.4.2.4

FIGURE 1

TF50 Pancake Drift
1164 Units Tested
Units Passed ICBQ after
20 hr. Joy Bomb at 100 psi.
Summary of testing from
10/60 through 12/60

Assigned Limit of Sensitivity

Number of Units



TASK II

PURPOSE

- A.** The purpose of this Task is to modify an existing pancake package and an existing internal device structure to develop a transistor 0.072" maximum height and 0.265" maximum diameter having as the objective specification the military 2N696-697 specification MIL-s-19500/99A. Maximum diameter was reduced during the course of the contract to 0.250".
- B.** To establish assembly techniques.
- C.** To fabricate and submit samples of these devices for approval and standardization.

II. 1 Analysis of Task

Figure 1(a) (Section III) and Drawing TD43-2 (Appendix D) show package and pellet status at initiation of contract. Figure 8 (Section III) is the initial header drawing. Drawing TD43-2 (Appendix D) shows the completed pellet which was being manufactured, having the electrical characteristics of MIL-S-19500/99A. The dimensions and geometries were quite compatible and the principal task was to refine both so that highest reliability and greatest ease of fabrication were obtained.

II. 2 Dimensional Design

No dimensional design change was considered or made on the original silicon mesa pellet. The standard 2N696-697 pellet was adequate for the package. There were two approaches to combining the package with the pellet, one involved using the header as is (Figure 9, Section III) the other consisted of using a molybdenum pedestal upon which the pellet is mounted (Figure 10, Section III). It was found that the latter approach was the most practical based on both, ease of mounting to the header, and ease of thermo compressive bonding.

A major change in package dimensions was agreed upon, during the contract, which changed the package flange diameter from .265" to .250" (Figure 4(a), Section III).

II. 3 Development of Assembly Procedures

II. 3. 1 Foreword: The purpose of this contract simply stated was to take an existing device pellet, the 2N696-697 and an existing package design, the pancake package Figure 1(a) (Section III), and develop techniques which would enable the manufacturer to produce the 2N696-697 device in the pancake package. These two parts, package and device pellet, were not developed as a part of this contract and their development prior to the contract is therefore not reported herein.

II. 3. 2 Internal Assembly and Lead Attachment

Figure 10 (Section III) illustrates the position of the pellet upon the pedestal and the arrangement of the bonding wires. The pellet was mounted on the gold plated moly pedestal in a K & S Model 601 header mounting machine. A 0.5 mil gold-antimony preform was used between pellet and pedestal in order to accomplish this. Gold wires, 1 mil thick, were thermocompressively bonded to the aluminum stripes and to the posts of the package using a K & S thermocompressive bonder (Model #400). These two operations required slight modifications of the above mentioned equipment in order to handle the pancake package.

II. 3. 3 Major Problem Areas

The attachment to the header and subsequent gold plating of the molybdenum pedestal was the major problem; however, a satisfactory technique using brazing and double gold plating was developed as described in this report Section III. 3. Other problems, such as vendor ability to meet specified tolerances, welding procedures and gold plating were encountered and are also described in Section III of this report.

Although an existing epitaxial pellet structure was considered, it was decided that a non-epitaxial device would best meet the objective requirements of MIL-S-19500/99A, and the needs of the Signal Corps. All samples delivered were fabricated with standard pellet structure.

II. 4 Fabrication of Models for Delivery

II. 4. 1 Subassembly and Parts

		<u>Drawing No.</u>
Header	(Figure 10, Section III)	B31-S-1411-P2
Cap	(Figure 6, Section III)	X-33124-P74
Silicon Mesa Pellet	(Appendix D)	TD 43-2
Lead Wire	(Appendix D)	PR-142

II. 4. 2 Assembly Process Specifications

Header Mounting	(Appendix D)	TD 43-2-P26
Bonding	(Appendix D)	TD 43-2-P27

Using parts and specifications listed above, 100 development models were built in 0.250" diameter packages, evaluated, and delivered.

II. 5 Test and Evaluation

II. 5. 1 One hundred development models were submitted to the Signal Corps on August 4, 1961. A summary of the results evaluated against MIL-S-19500/99A is given in Table I.

II. 5. 2 Conclusions

The Sylvania NPN silicon mesa, 2N696-697 junction, was successfully mounted in a modified Sylvania "pancake" package less than 0.072" high and less than 0.250" diameter. The final development models delivered, met or exceeded all of the requirements of the objective specification MIL-S-19500/99A.

TABLE I

GROUP A - Test Results

TABLE I (Continued)
SILICON MESA PANCAKE TRANSISTOR EVALUATION
RESULTS PER MIL-S-19500/99A

GROUP A Test Results				R _{TH} @ J-C
Parameter Condition	-	I _{CBO} T _A = 150°C ± 3° V _{CB} = 30 V I _E = 0	h_{FE} I _C = 500 ma V _{CE} = 10 V P _W ≤ 10 usec ≤ 5% duty cycle	I _C = 10 ma V _{CE} = 10 V
Test Equipment		T-569	AL-2	T-166
Limits		(<100ua)	(> 12.5, > 20) (Note 5)	(> 15, > 30) (Note 5)
SUBGROUP 4				
Maximum		80.0		
90%		6.4		
Median		1.0		
10%		0.2		
Minimum		0.1		
ZERO UNITS FAILED SUBGROUP 4; °/100				
SUBGROUP 5				
Maximum			83.3	154.0
90%			65.0	118.0
Median			43.4	67.3
10%			27.7	50.0
Minimum			20.0	38.0
ZERO UNITS FAILED SUBGROUP 5; °/100				
SUBGROUP 6				
Number of units tested = 10				
Maximum				41.2
90%				35.0
Median				32.8
10%				31.4
Minimum				29.6
ZERO UNITS FAILED SUBGROUP 6; °/100				

TABLE I (Continued)
SILICON MESA PANCAKE TRANSISTOR EVALUATION
RESULTS PER MIL-S-19500/99A

GROUP B Test Results

Subgroups 2, 3 and 4 were evaluated for I_{CBO} at $V_{CB} = +30$ VDC (limit $< 2\mu A$), V_{CE} (sat) at $I_C = 150$ mA, $I_B = 15$ mA (limit < 1.65 VDC), and V_{BE} (sat) at $I_C = 150$ mA, $I_B = 15$ mA (limit < 1.45 VDC).

Subgroups 6-7, the life tests, were evaluated for I_{CBO} at $V_{CB} = +30$ VDC (limit $< 2\mu A$) and h_{FE} at $I_C = 150$ mA, $V_{CE} = 10$ VDC, $P_W \leq 12$ m sec, and duty cycle 2% (limit > 15 and > 30 cycles).

SUBGROUP 1

Physical Dimensions 12 Failures, Lead Diameter; 12 Failures, 15 Tested, Note 1.

SUBGROUP 2

	Initial Reading	After Temp. Cycling, 5 cycles, T_{max} $= 200^\circ C$	After Moisture Resistance Test
	I_{CO} (μA)	limit $< 2.0 \mu A$ I_{CO} (μA)	limit $< 2.0 \mu A$ I_{CO} (μA)
Maximum	0.190	0.360	0.350
Median	0.010	0.010	0.040
Minimum	0.005	0.005	0.005
	V_{CE} (volts)	limit < 1.65 V V_{CE} (volts)	limit < 1.65 V V_{CE} (volts)
Maximum	0.876	0.898	1.070
Median	0.432	0.580	0.520
Minimum	0.214	0.217	0.219
	V_{BE} (volts)	limit < 1.45 V V_{BE} (volts)	limit < 1.45 V V_{BE} (volts)
Maximum	1.200	1.270	1.250
Median	1.010	0.100	1.010
Minimum	0.945	0.944	0.941

ZERO UNITS FAILED OF 15 UNITS TESTED; 0/15

TABLE I (Continued)
SILICON MESA PANCAKE TRANSISTOR EVALUATION
RESULTS PER MIL-S-19500/99A

GROUP B Test Results

SUBGROUP 3

	<u>Initial Reading</u>	<u>Constant Accelera- tion 20,000G</u>	<u>Shock 500G</u>	<u>Vibration Fatigue 20G</u>	<u>Vibration Variable Freq. 20G</u>
	$I_{CO}(\mu A)$	$I_{CO}(\mu A)$	$I_{CO}(\mu A)$	$I_{CO}(\mu A)$	$I_{CO}(\mu A)$
Maximum	0.192	0.187	D. S. *	D. S. *	D. S. *
			(0.277)	(1.17)	(0.592)
Median	0.012	0.024	0.037	0.063	0.104
Minimum	0.002	0.003	0.003	0.006	0.003
	V_{CE} (volts)	V_{CE} (volts)	V_{CE} (volts)	V_{CE} (volts)	V_{CE} (volts)
Maximum	1.090	C. S. *	C. S. *	C. S. *	C. S. *
		(1.10)	(1.11)	(1.12)	(1.12)
Median	0.681	0.684	0.710	0.702	0.697
Minimum	0.417	0.341	0.419	0.425	0.415

*1 UNIT FAILED, Emitter OPEN AFTER CONSTANT
ACCELERATION; 1/15, NOTE 2

SUBGROUP 4

	<u>Initial Reading</u>	<u>Salt Atmosphere</u>
	$I_{CO}(\mu A)$	$I_{CO}(\mu A)$
Maximum	0.216	29.800 *
Median	0.019	0.022
Minimum	0.004	0.002
	V_{CE} (volts)	V_{CE} (volts)
Maximum	1.200	1.200
Median	1.090	1.090
Minimum	0.986	0.976

*1 UNIT FAILED, I_{CO} LIMIT; 1/15, NOTE 3

SUBGROUP 5

Lead Fatigue

ZERO LEADS BROKE; 0/15

TABLE I (Continued)
 SILICON MESA PANCAKE TRANSISTOR EVALUATION
 RESULTS PER MIL-S-19500/99A

GROUP B Test Results

	<u>Initial Reading</u>	<u>After 250 hrs.</u>	<u>After 500 hrs.</u>	<u>After 750 hrs.</u>	<u>After 1000 hrs.</u>
--	----------------------------	---------------------------	---------------------------	---------------------------	----------------------------

SUBGROUP 6

Operating Life $T_A = +25^\circ\text{C}$, $V_{CB} = 30\text{V}$, $P_C = 400\text{ mw}$

I_{CO} at $V_{CB} = 30\text{ V}$ ($<2\mu\text{a}$)

Maximum	0.680	0.290	0.370	0.986	1.350
Median	0.150	0.045	0.035	0.074	0.065
Minimum	0.005	0.005	0.001	0.002	0.0026

h_{FE} at $I_C = 150\text{ mA}$, $V_{CE} = 10\text{ V}$, $P_W \leq 1\text{ m sec}$, Duty Cycle 2% ($>15 >30$)
(Note 5)

Maximum	74.6	87.7	79.4	79.8	79.4
Median	54.1	59.8	57.5	55.3	53.9
Minimum	43.1	43.1	41.9	43.1	43.0

ZERO UNITS FAILED. 0/15

SUBGROUP 7

$+300^\circ\text{C}$ Storage Life

I_{CO} at $V_{CB} = 30\text{ V}$ ($<20\mu\text{a}$)

Maximum	0.400	0.158	0.514	1.180	0.549
Median	0.090	0.055	0.085	0.084	0.049
Minimum	0.005	0.002	0.002	0.003	0.003

h_{FE} at $I_C = 150\text{ mA}$, $V_{CE} = 10\text{ V}$, $P_W \leq 12\text{ m sec}$, Duty Cycle 2% (>15 and >30)
(Note 5)

Maximum	59.8	74.2	64.9	64.9	72.2
Median	51.9	60.2	53.2	53.6	56.0
Minimum	45.2	45.2	37.6	36.5	37.8

ZERO UNITS FAILED - 2 UNITS DEVELOPED BROKEN LEADS AND
 WERE NOT EVALUATED. 0/13 NOTE 4

Note 1.

Samples passed all dimensional requirements except 12 units out of 15 had leads 0.001 inch greater than the required diameter. Header plating is corrected to eliminate this oversize condition.

Note 2.

Group B, Subgroup number 3 had one failure after Constant Acceleration at 20,000 G. This unit failed because the emitter lead connection came loose internally at the post. Bonding procedure corrected.

Note 3.

Radiflo test showed unit to be hermetically tight.

Note 4.

Group B, Subgroup number 7, + 300⁰C storage life, had zero failures. Two units were not evaluated during life due to broken external package leads. The broken leads were due to use of incorrect test jigs for the electrical measurements. After 1000 hours storage I_{CBO} was measured and both units were good for that parameter (number 11 - 0.002 μ a and number 13 - 0.001 μ a).

Note 5.

All testing was done as per MIL-S-19500/99A (Sig C). Two limits are given for h_{FE} and h_{fe} measurements because units were to be classified as SYL 2099 (2N696) and SYL 2445 (2N679); the last specified limit is for the SYL 2445.

SECTION III

PURPOSE

- A. The purpose of this work was to modify the existing Sylvania pancake package to accomodate a drift field germanium transistor and a silicon mesa switching transistor. The work was carried out in support of Tasks I and II.
- B. To establish manufacturing capabilities for the modified package design and to fabricate a sufficient number of parts to demonstrate capability and provide parts for fabrication of samples required in Tasks I and II.

III. 1 GeneralIII. 1. 1 Design

The package was designed by Sylvania prior to the contract as a resistance-welded hermetic enclosure consisting of a kovar stamping with kovar terminals sealed in with 7052 (hard) glass in a stress-free oxide seal. The outline is illustrated in Figure 1(a) and 1(b). (The outline later became EIA TO-47.) Lead wires were .014" in diameter in order to provide enough current-carrying capacity and sufficient stiffness to allow direct insertion into printed-circuit boards. The entire package was tin plated for corrosion resistance and solderability. The pin circle diameter was at .141", the smallest allowing insertion into a standard .100" grid circuit board. Experimental units with seal lengths of .040" and .030" were fabricated and tested hermetically. It was found that a seal length of .030" allowed some leaks after the thermo-mechanical shock of welding a SAE 1010 steel cap to the header in a resistance welder. A .035" seal length was decided upon. For the given diameter, it was calculated (Figure 2) that a stock thickness of .009" was necessary to allow hydrostatic pressure testing at 200 psig with less than a .001" deflection. Steel caps were stamped from copper-coated steel to inhibit rusting of the cap, to allow closer tolerances, and to provide longer tool life by action of the copper as a die lubricant.

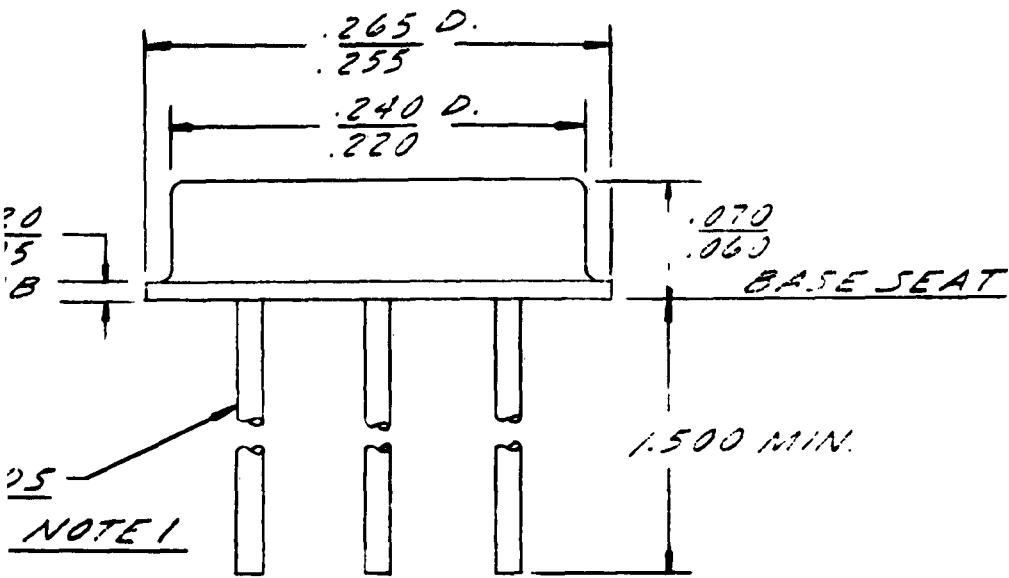
An indexing tab was provided for easy lead orientation and automatic insertion. The flange diameter of the cap (Figure 3) was made smaller than the flange diameter of the header in order to protect against weld flash, and the flange of the cap was angled to provide a projection for current-concentration in welding.

After the .265" diameter package was tooled and considerable experience was gained in welding the package, it was found that thinning of stock during drawing, use of overlapping tolerances and close control of welding electrodes would enable reduction of the diameter of the package to .250" (Figure 4(a) and 4(b)). With retooling for .250" maximum diameter package, defects in the original stampings were corrected thus providing a reliable, manufacturable package suitable for high-volume production.

III. 1. 2 Capacitance

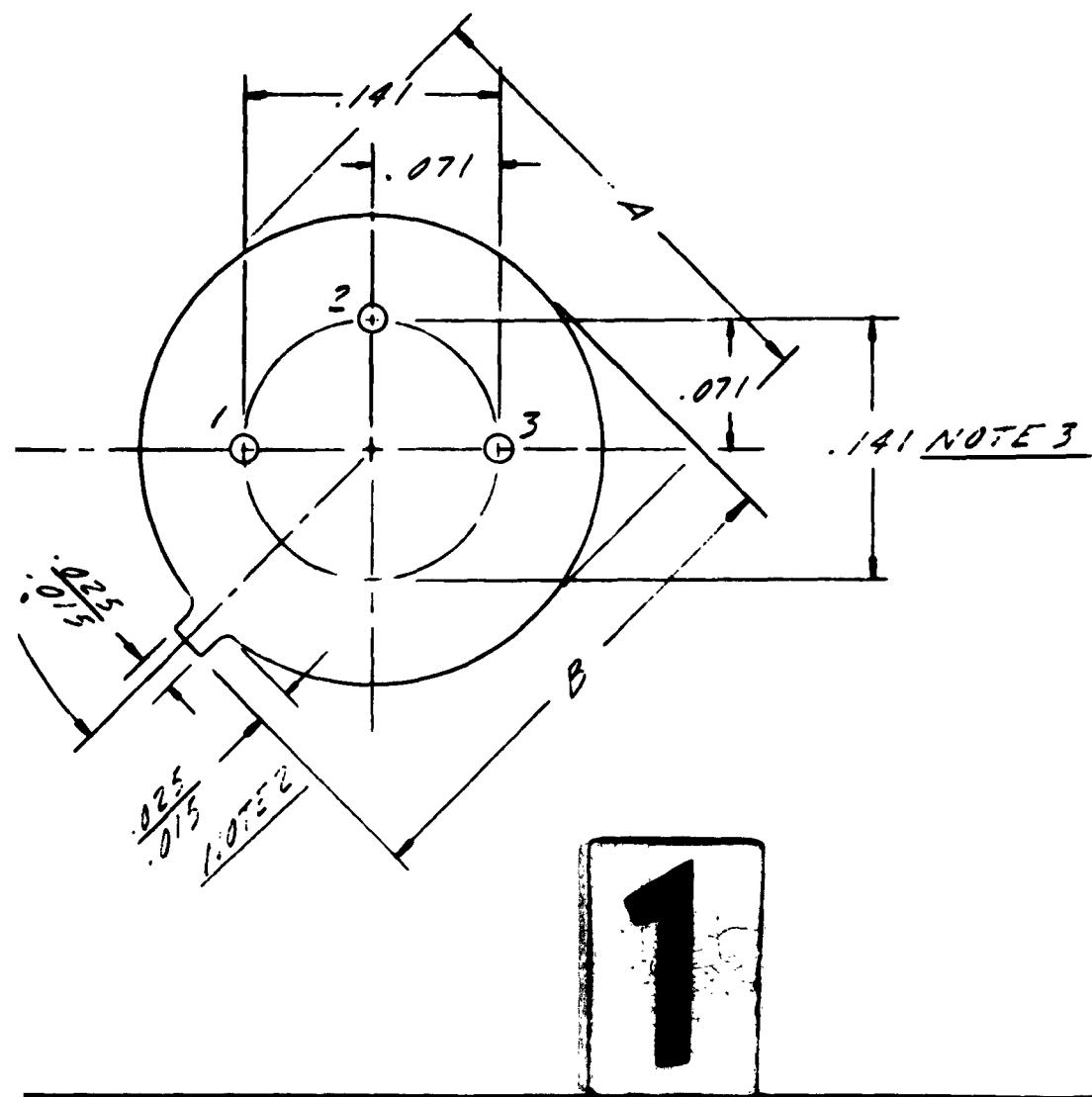
Lead-to-case capacitance of the package was measured with a Boonton Q-meter and compared with the TO-5 and TO-18.

TO-5	0.65 pf
TO-18	1.45 pf
TO-47 (Pancake)	0.95 pf



— NOTES : —

1. THIS DEVICE
CIRCUIT BO
APPLICATION
SIDED OR
SIMILAR AP
BRIDGING A
WASHER OR
MAY BE NO
2. SPECIFIED
BETWEEN .0
OUTSIDE TH
UNCONTROL
3. TABLE LENGTH
DIMENSION
4. MAX. DIA. L
PLANE .023
BE WITHIN
1/16 RESPECT



- CNGO-1933

MACHINING TOLERANCE UNLESS OTHERWISE NOTED		
FRACTIONAL $\pm 1/64$	DECIMAL $\pm .008$	ANGULAR $\pm 0^\circ 15'$

REMOVE ALL BURRS
AND SHARP EDGES.

REVISIONS

ES: -

THIS DEVICE IS FOR SOCKETED, SINGLE - SIDED CIRCUIT BOARD, WIRE - IN & SIMILAR APPLICATIONS. WHERE USED IN DOUBLE - SIDED OR EYELETED CIRCUIT BOARD, OR SIMILAR APPLICATIONS WHERE SOLDER BIDGING MAY OCCUR, A DIELECTRIC WASHER OR OTHER STAND - OFF DEVICE MAY BE NECESSARY.

SPECIFIED LEAD DIA. APPLIES IN THE ZONE BETWEEN .025 & 1.500 FROM BASE SEAT. OUTSIDE THIS ZONE, THE LEAD DIA IS UNCONTROLLED.

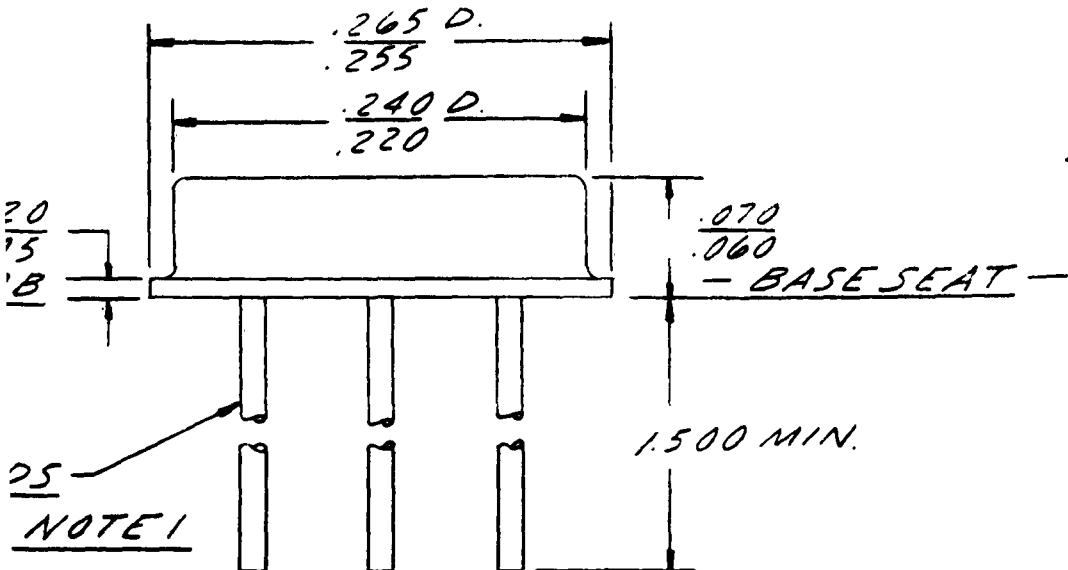
LEAD LENGTH DETERMINED BY SUBTRACTING DIMENSION "A" FROM DIMENSION "B". MAX. DIA. LEAD MEASURED AT A GAUGING PLANE $.025^{+.001}_{-.000}$ BELOW BASE SEAT SHALL BE WITHIN .007 OF THEIR TRUE POSITION RESPECT TO THE MAX. WIDTH TAB.



REO.	DRAWING NO.	NOTE	DESCRIPTION	ITEM	NEXT ASSEMBLY
	DRAWN		FINISH		
	DESIGNED		HEAT TREAT		
	APPROVALS	DATE	MATERIAL		
	DESIGN		EQUIP.		
	CHECKED ST. MC MANUS	^{.12} 12 1/2 1/2 1/2	PART	— OUTLINE —	
	DRAWN W. Stanley	1/2 1/2 1/2			
	SCALE		SYLVANIA	ELEC. PROD., INC. SEMICONDUCTOR DIVISION	B31-33426P54

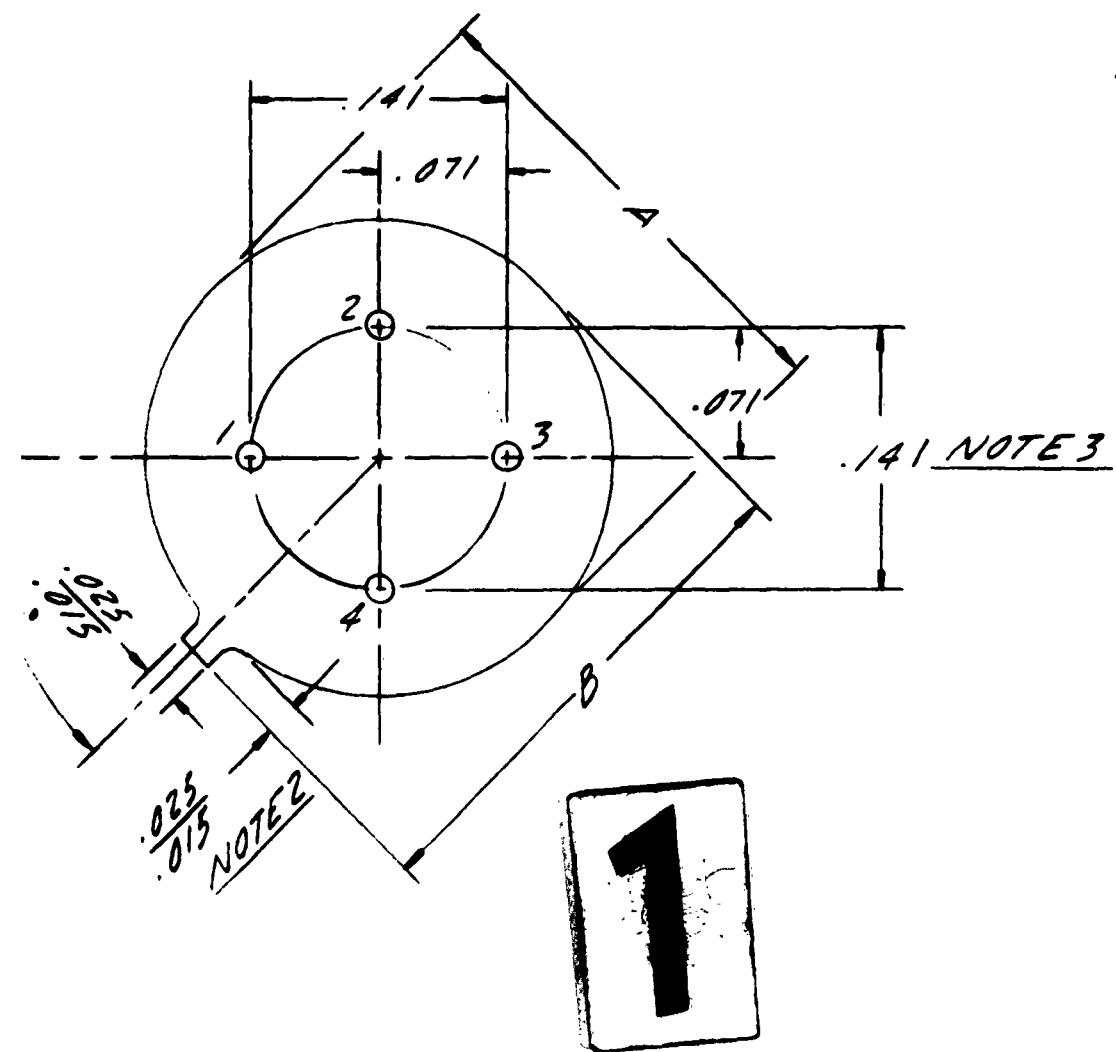
CN00-1933 -

2 -



- NOTES -

1. THIS DEVICE CIRCUIT BOA APPLICATION SIDED OR E SIMILAR AP. BRIDGING N WASHER OR MAY BE NE
2. SPECIFIED L BETWEEN N. O OUTSIDE TH UNCONTROL
3. TAB LENGTH DIMENSI
4. MAX. DIA. L PLANE. 02 BE WITHIN IN RESPEC



MACHINING TOLERANCE UNLESS OTHERWISE NOTED

FRACTIONAL $\pm 1/64$ DECIMAL $\pm .005$ ANGULAR $\pm 0^\circ-15'$ REMOVE ALL BURRS
AND SHARP EDGES.

REVISIONS

TES -

IS DEVICE IS FOR SOCKETED, SINGLE-SIDED CIRCUIT BOARD, WIRE-IN & SIMILAR APPLICATIONS. WHERE USED IN DOUBLE-SIDED OR EYELED CIRCUIT BOARD, OR SIMILAR APPLICATIONS WHERE SOLDER WIDGING MAY OCCUR, A DIELECTRIC SPACER OR OTHER STAND-OFF DEVICE MAY BE NECESSARY.

SPECIFIED LEAD DIA. APPLIES IN THE ZONE BETWEEN .025 & 1.500 FROM BASE SEAT. OUTSIDE THIS ZONE, THE LEAD DIA. IS CONTROLLED.

B LENGTH DETERMINED BY SUBTRACTING DIMENSION "A" FROM DIMENSION "B" MAX. DIA. LEAD MEASURED AT A GAUGING PLANE .025 $+.001$
 $-.000$ BELOW BASE SEAT SHALL BE WITHIN .001 OF THEIR TRUE POSITION IN RESPECT TO THE MAX. WIDTH TAB.



REG.	DRAWING NO.	NOTE	DESCRIPTION	ITEM	NEXT ASSEMBLY
	DRAWN		FINISH		
	DESIGNED		HEAT TREAT		
	APPROVALS	DATE	MATERIAL		
	DESIGN		EQUIP.		
	CHECKED STANLEY HANUS	13 May 1969	PART — OUTLINE —		
	DRAWN W. Stanley Hanus	13 May 1969	SYLVANIA	ELEC. PROD., INC. SEMICONDUCTOR DIVISION	B31-33456P-3
	SCALE				

CNGO.1934 -

29 -

Figure 2

CALCULATION OF CAP AND HEADER DEFLECTION

The following four pages of Figure 2 describe the design calculations used in determining cap dimensions and stock thickness.

CALCULATION OF CAP AND HEADER DEFLECTION

I. Bending of a uniformly loaded circular plate:
(from Timoshenko, Strength of Materials, Part II, 3rd Edition,
Van Nostrand, 1956)

For simply supported edges,

$$\delta_{\max.} = \frac{(5 + \mu) q a^4}{64 (1 + \mu) D}$$

For clamped edges,

$$\delta_{\max.} = \frac{q a^4}{64 D}$$

$$D = \frac{E h^3}{12 (1 - \mu^2)}$$

E = Modulus of elasticity (Young's), psi.

μ = Poisson's ratio

q = uniformly distributed load, psi.

a = radius of plate, in.

$\delta_{\max.}$ = maximum deflection (at center), in.

It is desired to have a total deflection (cap deflection plus header deflection) not greater than .002".

Figure 2 (Cont'd)

II. Considering simply supported edges,

$$s_{\max.} = \frac{(5+\mu) q a^4}{64 (1+\mu) D}$$

$$D = \frac{(5+\mu) q a^4}{64 (1+\mu) s_{\max.}} = \frac{E h^3}{12 (1-\mu^2)}$$

$$h^3 = \frac{12 (5+\mu) q a^4 (1-\mu^2)}{64 (1+\mu) E s_{\max.}}$$

$$h = \left(\frac{12 (5+\mu) (1-\mu^2) q a^4}{64 (1+\mu) E s_{\max.}} \right)^{1/3}$$

For steel,

$$\mu = 0.3$$

$$E = 30 \times 10^6 \text{ psi.}$$

For the cap,

$$a = .102 \text{ in.}$$

$$s_{\max.} = 1 \times 10^{-3} \text{ in.}$$

$$h = \left[\frac{12 (5.3) (.91) (200) (1.02)^4 \times 10^{-4}}{64 (1.3) (30 \times 10^6) 10^{-3}} \right]^{1/3}$$

$$h = 5.66 \times 10^{-3} \text{ in.}$$

For the header,

$$a = .124 \text{ in.}$$

$$h = \left[\frac{12 (5.3) (.91) (200) (1.24)^4 \times 10^{-4}}{64 (1.3) (30 \times 10^6) 10^{-3}} \right]^{1/3}$$

$$h = 13.76 \times 10^{-3} \text{ in.}$$

Figure 2 (Cont'd)

III. Considering clamped edges,

$$s_{\max} = \frac{q a^4}{64 D}$$

$$D = \frac{q a^4}{64 s_{\max}} = \frac{E h^3}{12 (1-\mu^2)}$$

$$h^3 = \frac{12 q a^4 (1-\mu^2)}{64 E s_{\max}}$$

$$h = \left(\frac{12 (1-\mu^2) q a^4}{64 E s_{\max}} \right)^{1/3}$$

For the cap,

$$h = \left[\frac{12 (.91) (200) (1.02)^4 \times 10^{-4}}{64 \times 30 \times 10^6 \times 10^{-3}} \right]^{1/3}$$

$$h = 3.54 \times 10^{-3} \text{ in.}$$

For the header,

$$h = \left[\frac{12 (1.09) (200) (1.24)^4 \times 10^{-4}}{64 \times 30 \times 10^6 \times 10^{-3}} \right]^{1/3}$$

$$h = 8.60 \times 10^{-3} \text{ in.}$$

IV. Header deflection:

Since we want to keep the cap stock and the header stock as close to the same thickness as possible for good welding, let us first find the header deflection for a simply-supported plate of the thickness calculated for a clamped plate. If the simply-supported plate deflection is less than .002", we can then calculate the stock thickness required for the cap to deflect no more than the difference between the header deflection and .002"

Figure 2 (Cont'd)

For simply-supported edges,

$$D = \frac{30 \times 10^6 (9)^3 \times 10^{-9}}{12 (.91)} = 2.47$$

$$s_{\max.} = \frac{5.3 \times 200 (1.24)^4 \times 10^{-4}}{64 (1.3) 2.47} = .0012"$$

V. Allowable cap deflection:

$$\begin{aligned} \text{Max. allowable total deflection} &= .002" \\ - \text{Calculated header deflection} &= .0012" \\ \text{Allowable cap deflection} &= .0008" \end{aligned}$$

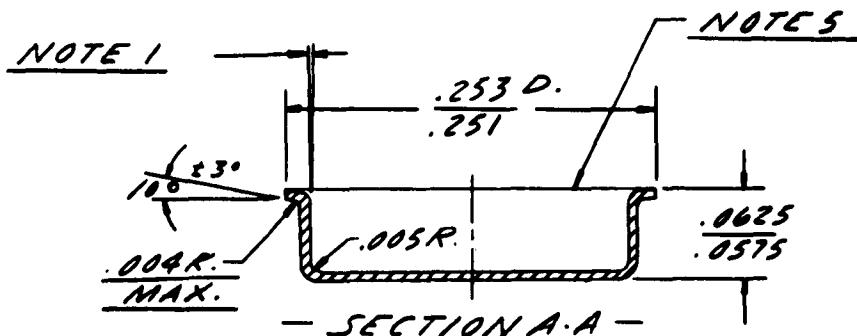
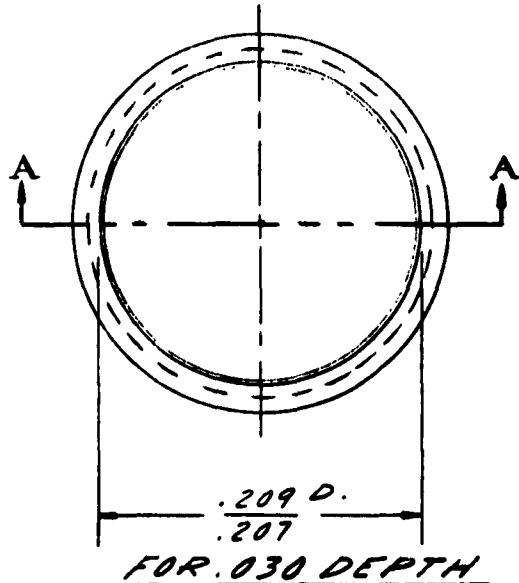
VI. Required cap stock thickness:

$$h = \left[\frac{12 (5.3) (.91) (200) (1.02)^4 \times 10^{-4}}{64 (1.3) (30 \times 10^6) (8 \times 10^{-4})} \right]^{1/3}$$

$$h = .0086"$$

Since kovar has a higher electrical resistivity than steel, and since the kovar header must be welded to the steel cap, metal thickness must be factored into welding. Since the steel resistivity is lower, and $R \propto L$, where L is path length, and since the heat generated at welding is proportional to R , it seems advisable to make cap stock thickness greater than header stock thickness in order to balance resistances in the welder circuit. The cap stock will therefore be made .001" thicker than header stock, or .010".

THIS PRINT TO BE REPLACED BY
A31-33124P74 ON 1 MAY 1961



— NOTES —

1. 10° MAX TAPER INSIDE OF SHELL
2. BODY TO FLANGE ECCENTRICITY .002 MAX. T.I.R.
3. THICKNESS OF FLANGE MUST NOT VARY MORE THAN ±.0005.
4. PART TO BE CLEARED BY FIRING IN A HYDROGEN ATMOSPHERE FURNACE AT 900°C FOR 20 MIN. KEEP ENTIRELY SURROUNDED BY GAS TO 200°C. PACK IN AIR-TIGHT CONTAINERS WHILE STILL AS HOT AS PRACTICABLE.
5. FLANGE TO BE FLAT WITHIN .001 WITH FACE FREE OF BURRS.

SM	REPLACEMENT NOTE ADDED CNC1-250 1/261	B
----	---	---

SM	Revised per CNC60-1751 2 May 1960	A
----	---	---

APPR'D	REVISIONS	LTR.
--------	-----------	------

ALL DIMENSIONS UNLESS OTHERWISE SPECIFIED ARE IN INCHES WITH TOLERANCES OF:

FRACTIONAL ± 1/64

DECIMAL ± .005

ANGULAR ± 1/2°

CNC60-1126 MATERIAL: .010 1010 CRS, COPPER PLATED

SYLVANIA ELECTRIC PRODUCTS, INC.
SEMICONDUCTOR DIVISION PLANT- WOLCOTT

TITLE:

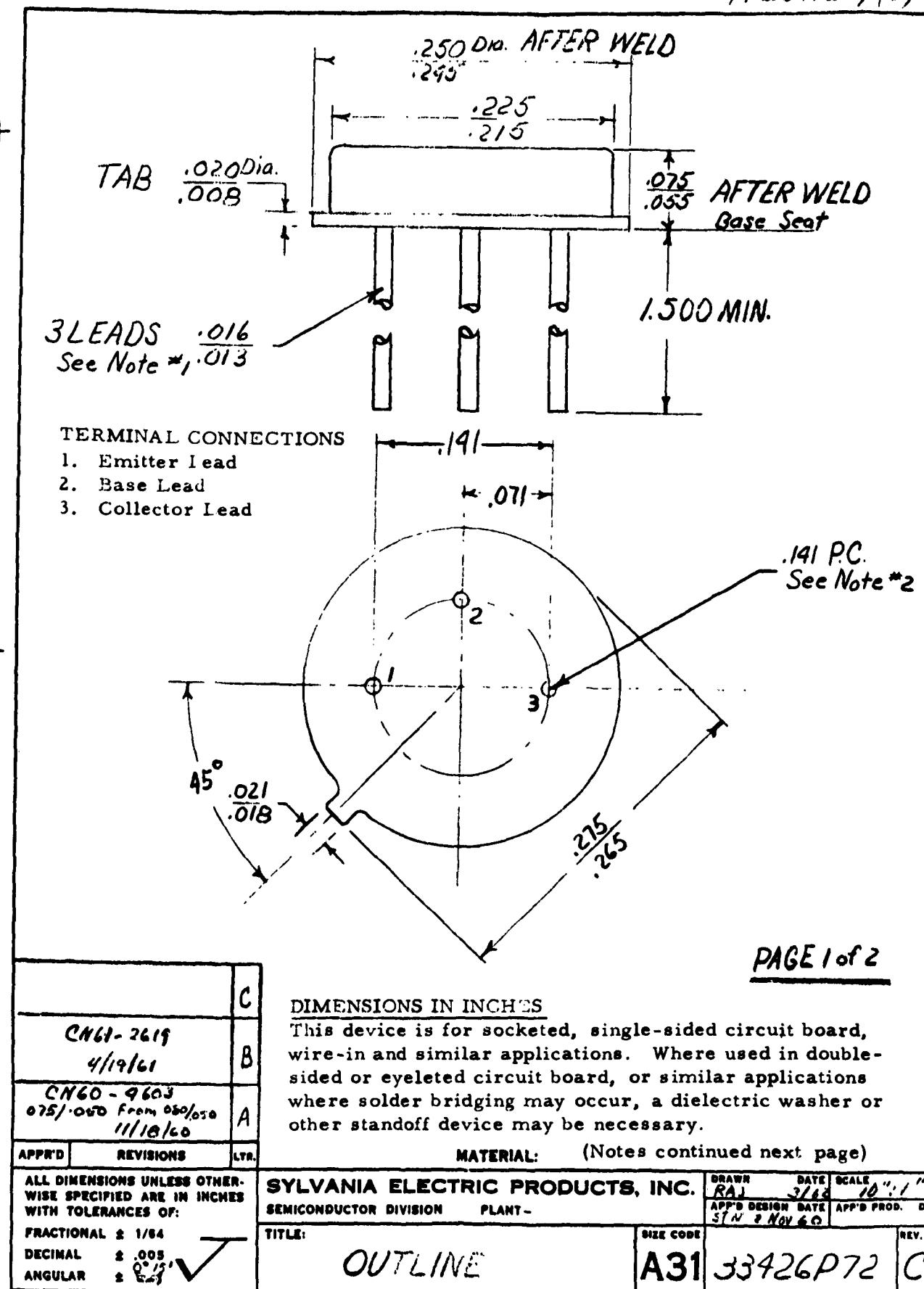
— CAP —

DRAWN W/1 APR 1960	DATE APR 1960	SCALE 10X
-----------------------	------------------	--------------

APP'D DESIGN DATE APR 1960	APP'D PROB. DATE APR 1960	REV. LTR.
-------------------------------	------------------------------	-----------

SIZE CODE A31	X33124-P71	B
------------------	------------	---

FIGURE 4(1)



NOTES

1. Specified lead diameter applies in the zone between .025 and 1.500 from 'base seat'. Outside of this zone the lead diameter is uncontrolled.
2. Maximum diameter lead measured at a gauging plane .025 .001 below 'base seat' shall be within .007 of their true position in respect to the maximum width tab.

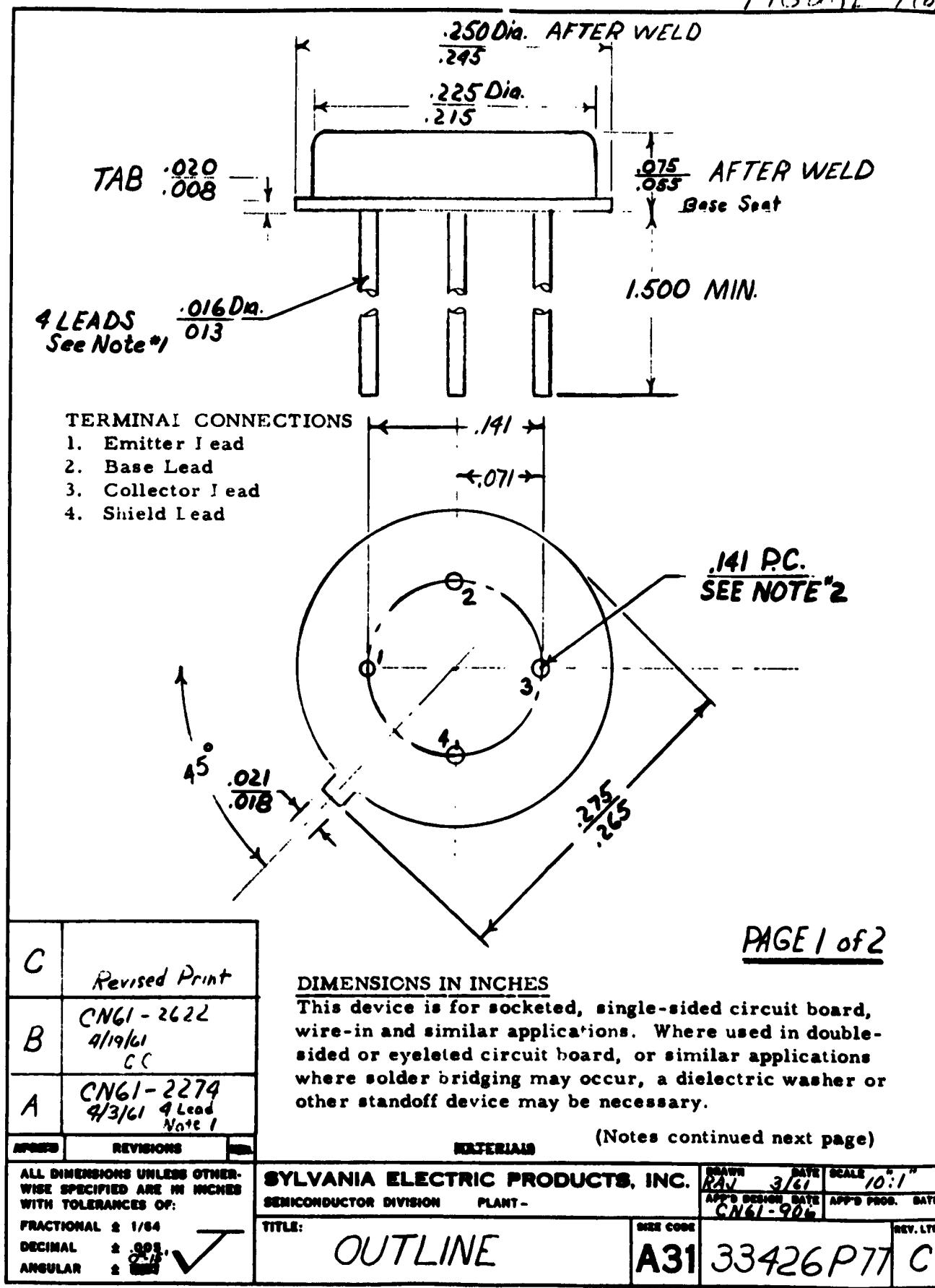
COPIES
TO

A

A-5

PAGE 2 of 2

APPR'D	REVISIONS	LT.R.	MATERIAL:		
ALL DIMENSIONS UNLESS OTHERWISE SPECIFIED ARE IN INCHES WITH TOLERANCES OF:			SYLVANIA ELECTRIC PRODUCTS, INC.		
FRACTIONAL $\pm 1/64$			SEMICONDUCTOR DIVISION PLANT-		
DECIMAL $\pm .005$			TITLE: OUTLINE		
ANGULAR $\pm 1/2^\circ$			SIZE CODE	DRAWN BY	DATE
			A31	SIN	7/6
				APPR'D DESIGN	DATE
				SIN	2 Nov 62
				APPR'D PROD.	DATE
					REV. LTR
					C



NOTES

1. Specified lead diameter applies in the zone between .025 and 1.500 from base seat. Outside of this zone the lead diameter is uncontrolled.
2. Maximum diameter lead measured at a gauging plane .025 .001 below base seat shall be within .007 of their true position .000 in respect to the maximum width tab.

COPIES
TO

A-5

PAGE 2 of 2

APPR'D	REVISIONS	LT.R.	MATERIAL:		
ALL DIMENSIONS UNLESS OTHERWISE SPECIFIED ARE IN INCHES WITH TOLERANCES OF:			SYLVANIA ELECTRIC PRODUCTS, INC.		
FRACTIONAL $\pm 1/64$			SEMICONDUCTOR DIVISION PLANT-		
DECIMAL $\pm .005$			TITLE: OUTLINE		
ANGULAR $\pm 1/2^\circ$			SIZE CODE	DRAWN DATE	SCALE
			A31	3/62	
				APPR'D DESIGN DATE	APPR'D PROD. DATE
				CN61-936	
					REV. LTR
					C

DEFIANCE NO. 1000H 08100

III. 1. 3 Lead Fatigue

Lead fatigue testing of finished transistors was done by holding the package in a fixture with the leads hanging vertically, attaching a one-pound, one-ounce weight to the end of a lead and cycling at a constant speed (ten bends per minute). One bend is defined as rotation of the body of the device through a 90° arc (lead held down by one pound weight) and back to 0° . All bends are in the same direction. Results obtained show an average number of bends per lead of 4.5, maximum of 14, minimum of 3.5. Data is shown below:

PACKAGE LEAD FATIGUE TEST RESULTS

(Sample 100)

<u>Number of 90° Bends</u>	<u>Incoming Part</u>	<u>Completed Transistor</u>
less than 3	0 failures	0 failures
3.5	0	9
4	3	10
4.5	14	32
5	10	8
5.5	37	5
6	3	4
6.5	7	3
7 - 14	4	4
14	22	25
	100	100

III. 2 Task I Package - Germanium Drift Field Transistor (2N384)

III.2. 1 Design Considerations

The 2N384 "drift-field" transistor required all elements electrically insulated from case and a fourth lead to the case. The header therefore has three glassed-in leads and the fourth lead butt-welded to the outside of the case.

III. 2. 2 Package Development

III. 2. 2. 1 Headers

The header originally used was part number B31-33127-P114 shown in Figure 5. Because of thinning of the stock in the drawing of the embosses, there was more space than anticipated across the eyelets and the eyelet walls were slanted. Also, the placement of the eyelets and emboss was off-center in respect to the outside diameter of the package. As a result, cap-to-header centering was difficult, and considerable trouble was encountered initially at welding. The situation was improved by reducing the inside diameter of the cap, but it was not until the part was retooled to reduce the diameter of the package to .250" (Figures 6 and 7) that the welding of the package became routine.

III. 2. 2. 2 Welding

Initially, a Raytheon "L" head condenser discharge welder with a Model 1101 power supply was used for seal welding. Results were satisfactory, but a change was later made to an "M" head welder to minimize electrode alignment error and forging of the base metal during welding. The improved alignment allowed changes in weld pressure and heat settings to obtain excellent hermetic seals without excessive forging. Maximum diameters achieved are between .248" and .250".

III. 2. 2. 3 Tab Attachment

It was proposed at the beginning of the contract to attach one end of the base tab to the base lead by soldering and the other end to the emboss in position four by means of an insulating adhesive. The tab, adhesive, emboss combination made a parallel plate capacitor, and, since the "drift-field" transistor was a high-frequency device, it was sensitive to extra capacitances. A test was undertaken to determine the average capacitance between base tab and case, and at the same time, to determine the resistance to thermal shock of any adhesive used. Four epoxies were evaluated for the necessary properties: SR98, a silicon resin; Laminac, a polyester resin; Ecco-bond 26, an epoxy adhesive made by Emerson and Cummings, Inc.; and Eastman 910 adhesive. The different materials were applied to sample units which were then baked for sixty hours to harden the epoxy. Capacitance and temperature cycle tests were made. With

POSITION LEGEND

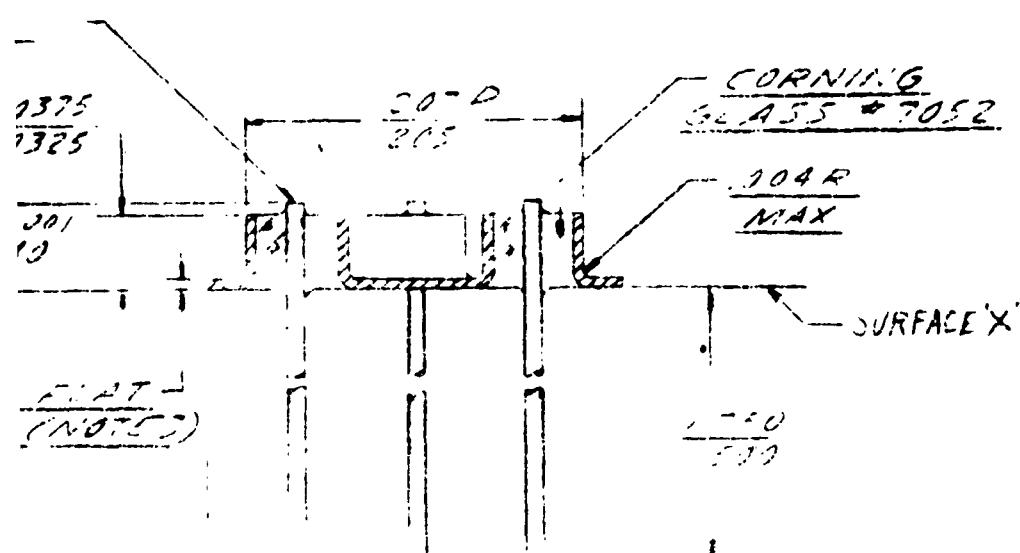
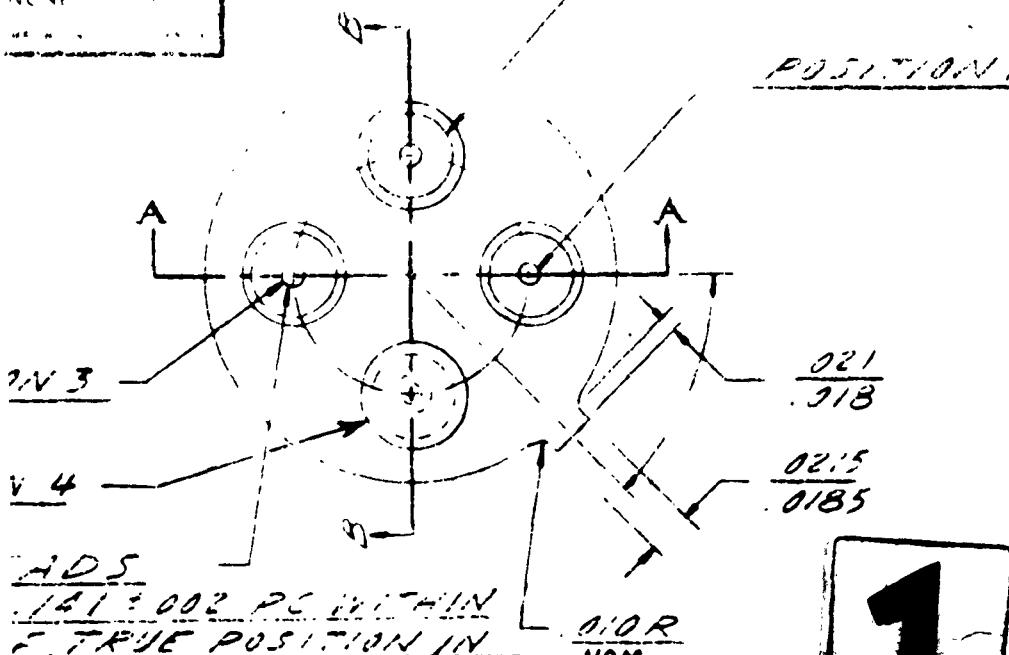
+	UP
-	DOWN
*	ROTATE
None	None
None	None

- 0.055 / 0.075 (4)

POSITION 2

6) NC GLA
WELD
SURFACE

POSITION 1



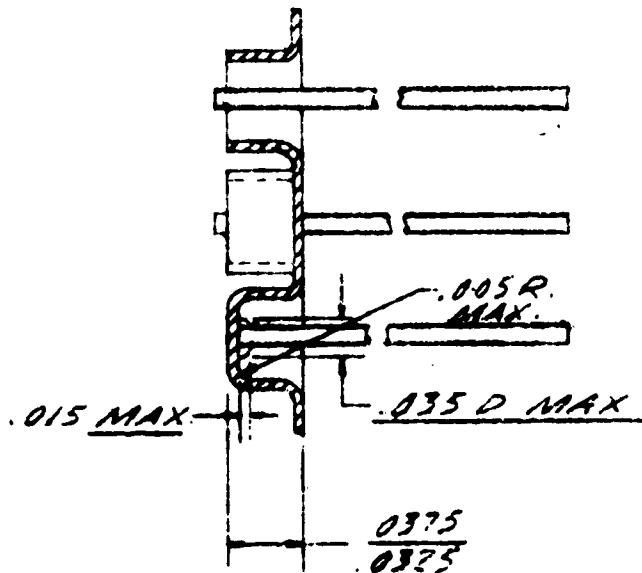
SECTION A-A

- CN 60-1234 -

MACHINING TOLERANCE UNLESS OTHERWISE NOTED

FRACTIONAL $\pm 1/64$ DECIMAL $\pm .0005$ ANGULAR $\pm 0^\circ.15^\circ$ HORIZONTAL, VERTICAL,
AND SHARP EDGES

6) NO GLASS, GLASS FATTER OR PARTICLES SHALL BE IN THE
WELD AREA INCLUDING NO. 7 IN TOP & BOTTOM FLANGE
SURFACES.



REVISIONS

A) .004 R. MAX.
WAS .003 R.
NOM. & .005 R.
MAX WAS .003 R.
NOM. PER
CN60-1753 10
2 MAY 60

B) ADD "CLEAR" TO GLASS
(CN61-2309 31 MAY 60)

C) REMOVED "D" FROM DIA.
(CN60-3691 31 MAY 60)

D) NOTE ADDED (6)
CN60-5220
1/2/61

E) REPLACEMENT
NO. ADDED
CN61-253 1-19-61

F) FROM LEADS TO LEAD
CN61-627 2-9-61

G) ADDED MEASURE ON
SURFACE X
CN61-149 3-31-61

TESTS:

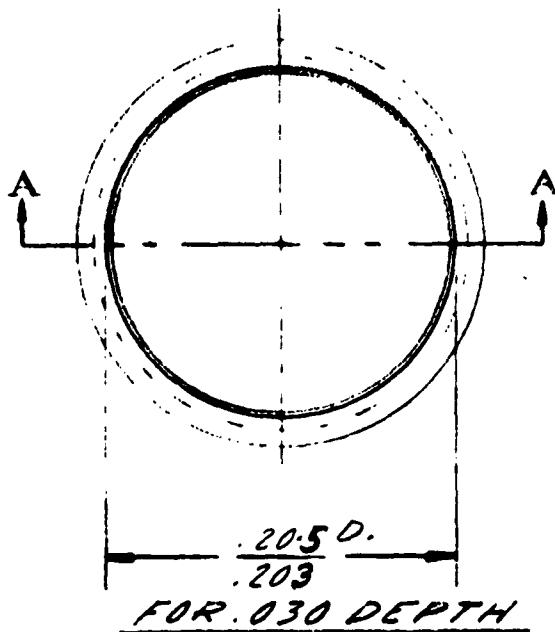
FINISH: BRIGHT DIP
AFTER WELDING STEM TO CAP SEALS TO PASS
X10-10 STD CC/SEC LEAK RATE
FLANGE THICKNESS OF ANY ONE PIECE MUST
ALL WITHIN .0005 INCLUDING TAB
CONCENTRICITY OF .207/.205 D & .260 D
MUST BE .002 MAX. T.I.R
INNER LEADS TO BE SURFACE GROUND TO LENGTH

2

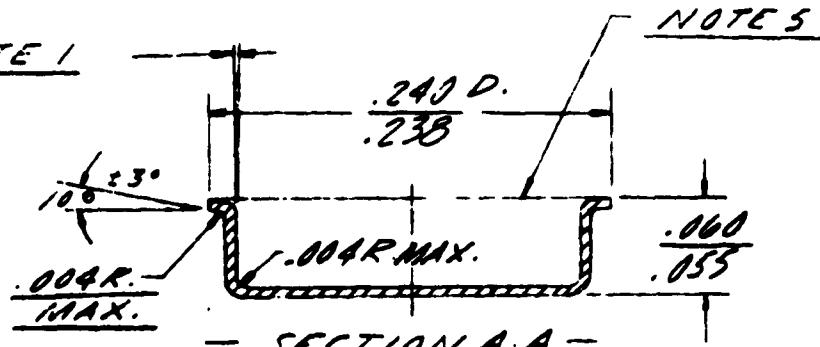
REF.	DRAWING NO.	NOTE	DESCRIPTION	ITEM	NEXT ASSEMBLY
	REASON		FINISH		
	REASONED		HEAT TREAT		SCLEAR
	APPROVALS	DATE	MATERIAL		REVA-104 EQUIV. TO V.G. 7052 GLASS
	DESIGN		EQUIP.		
	CHECKED	MM	PART	— HE ALICE —	
	DRAWN	MM			
	SCALE	10X	SYLVANIA	ELEC. PROD., INC. SEMICONDUCTOR DIVISION	B31- 33187-P114

BE REPLACED,
PMS ON 1 MAY 61

0-1834



NOTE 1



NOTE 5

NOTES

1. 1° MAX TAPER INSIDE OF SHELL
2. BODY TO FLANGE ECCENTRICITY .002 MAX TIR
3. THICKNESS OF FLANGE MUST NOT VARY MORE THAN ± .0005
4. PART TO BE CLEANED BY FIRING IN A HYDROGEN ATMOSPHERE FURNACE AT 900°C FOR 20 MIN. KEEP ENTIRELY SURROUNDED BY GAS TO 200°C. PACK IN Airtight CONTAINERS WHILE STILL AS HOT AS PRACTICABLE.
5. FLANGE TO BE FLAT WITHIN .001 WITH FACE FREE OF BURRS.

STN#	205	.208
18 MAY 1961	203 WAS .202	
	CN61-2319	
	4-10-61	

STN#	205/203 was .202 205-2000	APPROV.
APPROV	REVISIONS	STN#

ALL DIMENSIONS UNLESS OTHERWISE SPECIFIED ARE IN INCHES WITH TOLERANCES OF:	
FRACTIONAL	± 1/64
DECIMAL	± .005
ANGULAR	± 1/2°

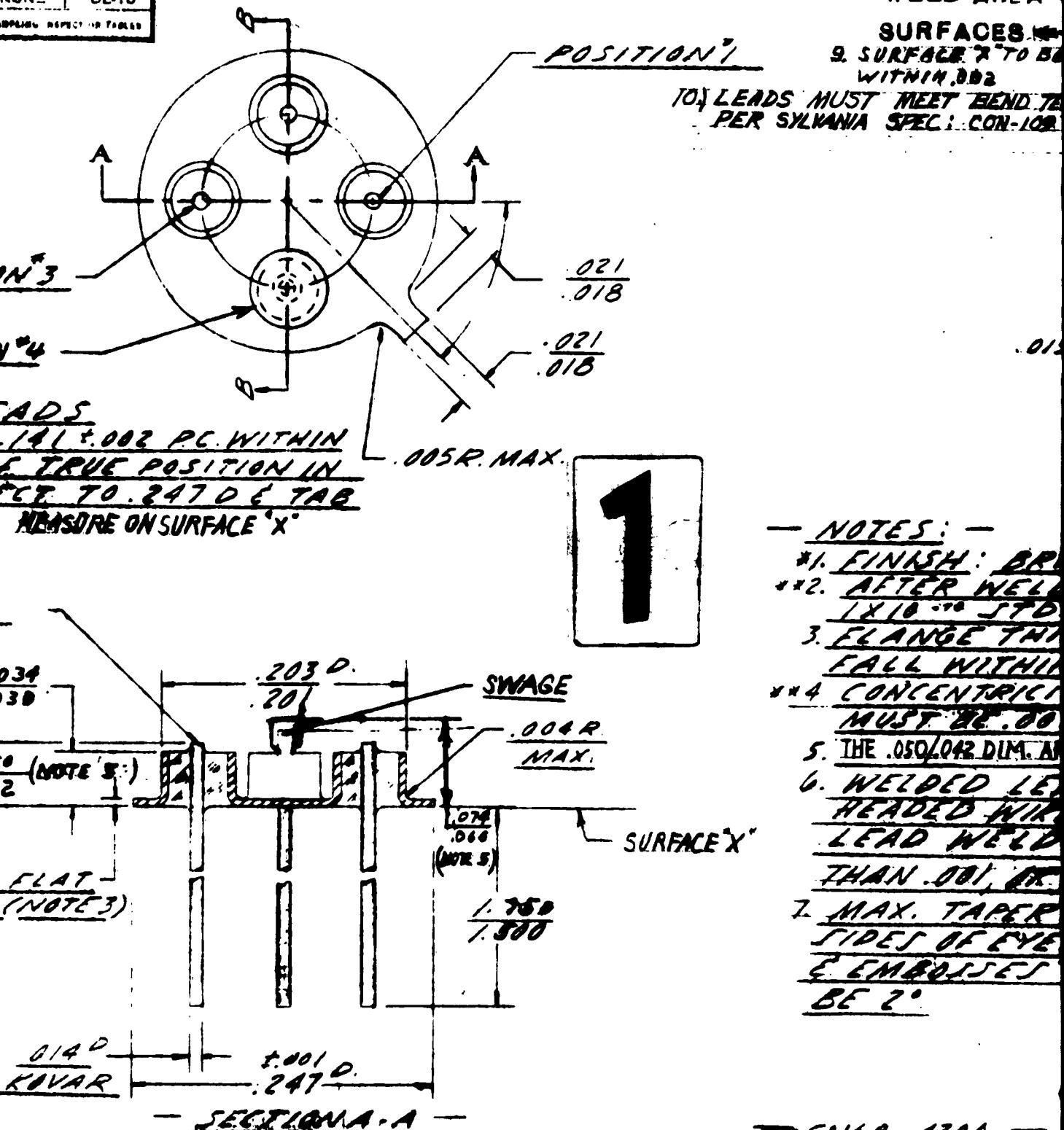
CN60-4304 MATERIAL: .008 1010 CRS, COPPER PLATED

SYLVANIA ELECTRIC PRODUCTS, INC. DRAWN BY: DATE: SCALE: 10X
SEMICONDUCTOR DIVISION PLANT: WOBURN APP'D DESIGN DATE: APP'D PROD. DATE:

TITLE: — CAP —	SIZE CODE: A31	REV. AT:
X33124-P74		B1

FIGURE 7

TOLERANCE LEGEND	
SYMBOL	SAMPLING PLAN
**	DL-5
*	DL-7
NONE	DL-10
DIMENSION REFERENCE TABLES	



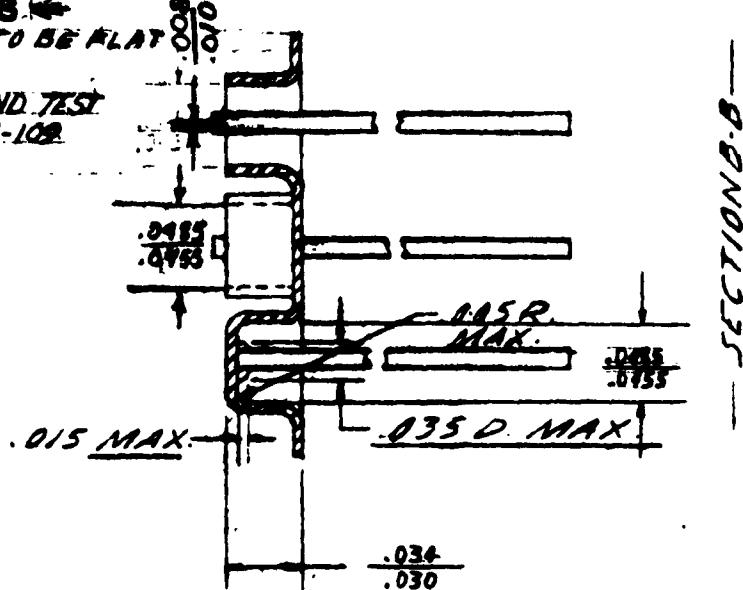
MACHINING TOLERANCE UNLESS OTHERWISE NOTED		
FRACTIONAL ± 1/64	DECIMAL ± .005	ANGULAR ± 0°-15'

REMOVING AND SWAP

NO GLASS SPATTER OR PARTICLES SHALL BE IN THE
WELD AREA - INCLUDING BOTH TOP & BOTTOM FLANGE

11URFACES  **11URFACE 7 TO BE FLAT**  **THIN 003** 

MEET BEND TEST
SPEC: CON-102



REVIEWERS

A) NO. GRASS SPATTER ADDED CN60-5820 1/13-61

B) ADDED MEASURE ON SURFACE "X" CN61-1152 2-14-61

C) REVISED PER CN61-4414 7-19-61

D) ADDED NOTE 58 DIM. CN61-4990 3-AUG-61

E) ADDED NOTE 10 CN61-5753 12-SEPM-61

5: -
FLASH: BRIGHT DIP
TER WELDING STEM TO CAP SEALS TO PASS
0.00 STD CC/SEC. OF AIR LEAK RATE.
INGE THICKNESS OF ANY ONE PIECE MUST
L WITHIN ± 0.0005 INCLUDING TAB.
CENTRICITY OF .203/.2010 E.2470.
ST DE.002 MAX. T.I.R.
.050.062 DIM. APPLIES TO BACKLEADS & TABS. THE .078.066 DIM APPLIES ONLY TO LEAD
LEAD MUST BE SPOT WELDED USING
WIRE & THE SURFACE OPPOSITE THE
WELD SHOULD NOT BE DEFORMED MORE
1.001, OR VISIBLE DISFIGURED



ITEM	DRAWING NO.	NOTE	DESCRIPTION	MATERIAL	NEXT ASSEMBLY	
					REASON	REASON
			FINISH			
			HEAT TREAT			
			MATERIAL	KOVAR OR EQUIV. & CORNING #7052 GLASS		SCREW
			EQUI?			
	100-1000	STM	PART	— HEADER — (MM2N389)		
		W. Starnes				
		DATE				
		SYN	SYLVANIA	ELEC. PROD. INC. SEMICONDUCTOR DIVISION	B31-3312TPH/10	

4306 -

卷之三

Eccobond 26 the parts adhered more quickly, and there was little difficulty in applying it only where needed. Mean value of capacitance using Eccobond was 1.8 pf; mean value using Laminac was 1.5 pf. SR 98 gave poor results in the first run and Eastman 910 cannot withstand temperatures greater than 83°C. Temperature cycle was performed on the first run by immersing units in boiling water, then in liquid nitrogen. After two cycles the units with SR 98 came apart. Of the units using Laminac, 25% remained intact; of the units using Eccobond 26, 50% remained intact; of the units using Eastman 910, 16% remained intact. In the second test, three of fifteen units with Laminac remained intact after two cycles. Twenty units out of twenty with Eccobond remained intact after two cycles and showed no defects under the microscope. Eccobond 26 was chosen. In devices, it readily passed thermal shock and cycle per MIL-S-19500.

For the first two quarters of the contract, attachment of the base tab to the base header lead was made by lead-tin soldering as had been originally planned. During the second quarter, it was found that this soldered connection failed in the 500 g. 1 msec shock test. A change was made to welded construction. The new process consisted of flattening the end of the base terminal with the terminal still vertical, and then bending the terminal and base tab down to allow the base tab to rest horizontally across the emboss in position four. Hermeticity tests showed that no damage had been done to the seals in the process of forming the base lead. The change from soldered to welded construction successfully eliminated shock and centrifuge failures.

III. 2.2.4 Hermeticity

Except for early difficulty in welding, no trouble was encountered with hermeticity during the entire contract period. Frequent samples were tested to a sensitivity of 1×10^{-11} std cc/sec. leak rate by the "Radiflo" method of leak detection. Of 1040 units tested between May and August 1961, 98.4% had leak rates less than 1×10^{-11} . Several JAN moisture tests were run with no failures.

III. 3 Task II Package - Silicon Mesa Transistor (2N696)

III. 3. 1 Design Considerations

In the "mesa" type of diffused transistor structure, the collector portion of the semiconductor die is usually bonded to a flat surface on the header, making the package electrically common with the collector. For this reason, a three-lead design was used, with emitter and base leads insulated from the case and the collector lead butt-welded to the outside of the case (See Figure 8).

III. 3. 2 Mounting Scheme

III. 3. 2. 1 Design

Initially, it was felt that the most straight-forward method of mounting the die in the package would be to bond or braze it directly to the stem assembly, either in the center (Figure 9) or between the emitter and base terminals.

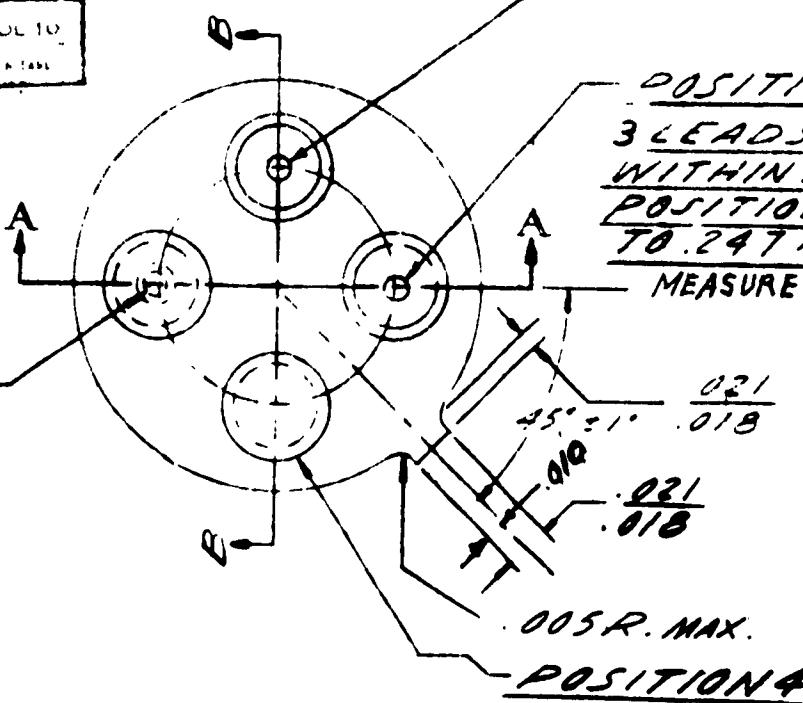
Because the die was to be mounted directly on the package, it was felt that the thermal impedance (junction to case) would be very low. However, mechanical problems were anticipated due to shorting of the bonding wires to the sides of the eyelets because the die would be so deep in the package. The length of the lead wires was also considered a possible trouble area because of the centrifuge requirement; and finally the restricted space was considered a detriment to lead bonding, since the bonding tool required maneuvering space.

For these reasons, another approach was considered. A solid disc or slug of metal was to be brazed, welded or soldered to the stem assembly between the eyelets as in Figure 10. The mesa die was then to be mounted on this "pedestal". Lead length and danger of shorting would be significantly reduced and bonding would be made easier, but it was feared that the thermal impedance would suffer. An approximate calculation of thermal impedance predicted $40^{\circ}\text{C}/\text{W}$ to $70^{\circ}\text{C}/\text{W}$ for the silicon mesa device in this package.

III. 3. 2. 2 Development

The first devices were made with no "pedestals", the die being mounted to the gold plating directly on the header. The anticipated difficulties were encountered. The space in the center was so small that thermocompression bonding to the emitter and base stripes was very difficult. The bonding wire was long and free to swing under mild shock.

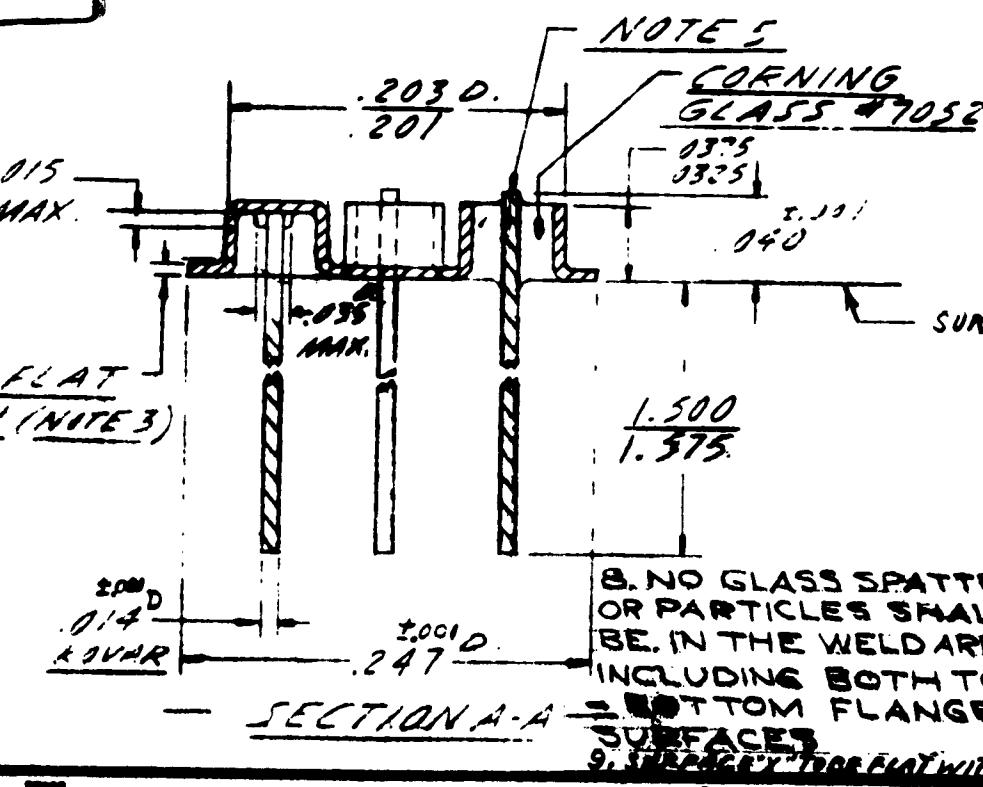
ION LEGEND	
SYMBOL	SAMPLING PLAN
**	DL-5
*	DL-7
None	DL-10
APPLICABLE INSPECTION TABLE	

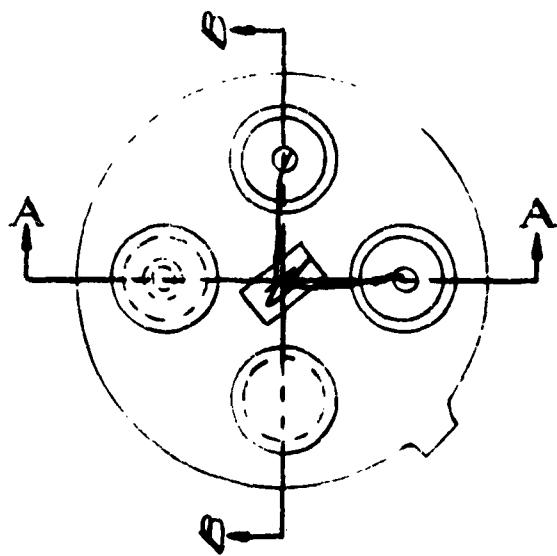


10. LEADS MUST MEET
PER SYLVANIA SPEC.
AND MIL-S-195
11. PLATE HEADER

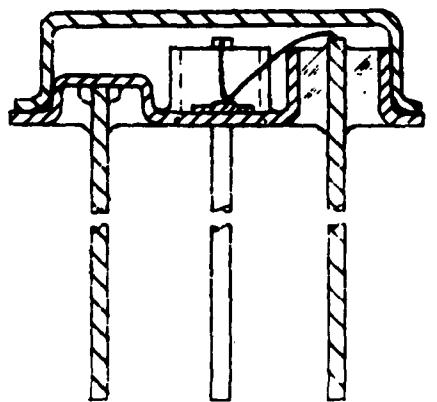
— NOTES —

- *1. FINISH: 1
- *2. AFTER WELDING: W
- 3. FLANGE THICKNESS: 1X10
- 4. FALL WITHIN: 1
- 5. CONCENTRICITY: 1
- 6. MUST BE WELDED: W
- 7. INNER LEAD LENGTH: 1
- 8. WELDED LEAD: W
- 9. HEADED LEAD: W
- 10. LEAD WELL: W
- 11. THAN .001, OR: W
- 12. VISIBLELY DISJOINED: W
- 13. 7. MAX. TAPER: 1
- 14. SIDES OF EYES: 1
- 15. EMBOSSES: W
- 16. BE 2°: W



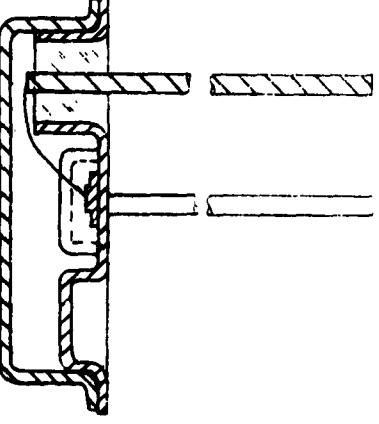


CAP REMOVED

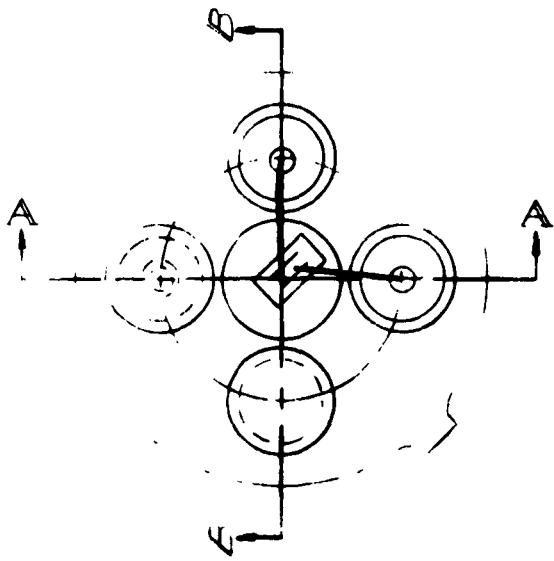


— SECTION A-A —

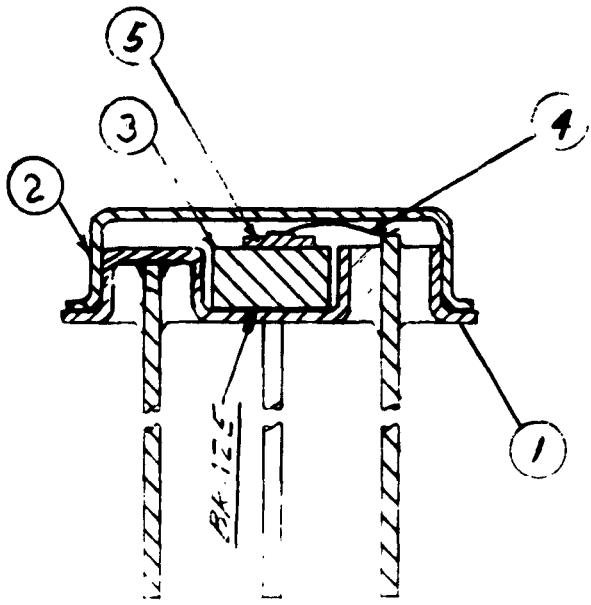
— CN60-1935 —

MACHINING TOLERANCE UNLESS OTHERWISE NOTED			REMOVE ALL BURRS AND SHARP EDGES.																																				
FRACTIONAL $\pm 1/64$	DECIMAL $\pm .005$	ANGULAR $\pm 0^{\circ}15'$																																					
REVISIONS																																							
																																							
																																							
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;">REQ.</th> <th style="width: 30%;">DRAWING NO.</th> <th style="width: 10%;">NOTE</th> <th style="width: 40%;">DESCRIPTION</th> <th style="width: 20%;">ITEM</th> </tr> </thead> <tbody> <tr> <td rowspan="5" style="text-align: center; vertical-align: top; width: 10%;">REVISIONS</td> <td>DRAWN</td> <td></td> <td>FINISH</td> <td></td> </tr> <tr> <td>DESIGNED</td> <td></td> <td>HEAT TREAT</td> <td></td> </tr> <tr> <td>APPROVALS</td> <td>DATE</td> <td>MATERIAL</td> <td></td> </tr> <tr> <td>DESIGN</td> <td></td> <td>EQUIP.</td> <td></td> </tr> <tr> <td>CHECKED ST. M'MANUS</td> <td>12 May 1962</td> <td>PART — ASSEMBLY —</td> <td></td> </tr> <tr> <td>DRAWN W. J. Stanley</td> <td>12 May 1962</td> <td colspan="2" style="text-align: center; vertical-align: middle;">  ELEC. PROD., INC. SEMICONDUCTOR DIVISION </td> </tr> <tr> <td>SCALE</td> <td></td> <td colspan="2"></td> <td style="text-align: right;">B31-S-1411P1</td> </tr> </tbody> </table>					REQ.	DRAWING NO.	NOTE	DESCRIPTION	ITEM	REVISIONS	DRAWN		FINISH		DESIGNED		HEAT TREAT		APPROVALS	DATE	MATERIAL		DESIGN		EQUIP.		CHECKED ST. M'MANUS	12 May 1962	PART — ASSEMBLY —		DRAWN W. J. Stanley	12 May 1962	 ELEC. PROD., INC. SEMICONDUCTOR DIVISION		SCALE				B31-S-1411P1
REQ.	DRAWING NO.	NOTE	DESCRIPTION	ITEM																																			
REVISIONS	DRAWN		FINISH																																				
	DESIGNED		HEAT TREAT																																				
	APPROVALS	DATE	MATERIAL																																				
	DESIGN		EQUIP.																																				
	CHECKED ST. M'MANUS	12 May 1962	PART — ASSEMBLY —																																				
DRAWN W. J. Stanley	12 May 1962	 ELEC. PROD., INC. SEMICONDUCTOR DIVISION																																					
SCALE				B31-S-1411P1																																			

-1935 -



SA - REMOVED



— NOTES —

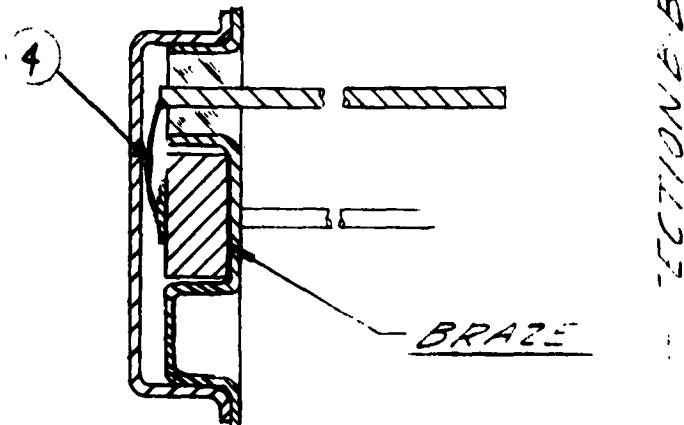
1. PROCESS SPECIFIC

— SECTION A-A —

— CNGO-1936 —

MACHINING TOLERANCE UNLESS OTHERWISE NOTED			REMOVE ALL BURRS AND SHARP EDGES.
FRACTIONAL $\pm 1/64$	DECIMAL $\pm .005$	ANGULAR $\pm 0^\circ-15'$	

REVISIONS



REQ.	DRAWING NO.	NOTE	DESCRIPTION	ITEM
	TD 43-2-P26	1	THERM COMP BOND	
	TD 43-2-P26	1	HEADER MOUNTING	
	F-30	1	BRAZING OPERATION	
1	A31-9253P140		SILICON MESA PELLET	5
2	PR 142		WIRE	4
1	A31-6105P38		PEDESTAL	3
1	A31-X33124P74		CAP	2
1	B31-33127P180		PLATE/HEADER	1

2

MODEL NO.	DRAWN	FINISH	NEXT ASSEMBLY
	DESIGNED	HEAT TREAT	
	APPROVED	DATE	
	DESIGN		
	CHEKED	12 ST. MC MONAGH	
	DRAWN W. Stancy	12 MAY 68	
	SCALE		PART — ASSEMBLY —
			SYLVANIA
			ELEC. PROD., INC. SEMICONDUCTOR DIVISION
			B31-S-1411PC

SPECIFICATION

0-1936 —

Also, because of the roughness of the header due to draw marks in the metal, the yield was very low. It was therefore decided that a mounting platform ("pedestal") of a high thermal conductivity material would be used.

Copper Pedestal

The first, natural choice of materials was OFHC copper, to be used for its high thermal conductivity and brazability. The copper pedestals were brazed to the headers in a "pusher" type furnace, a CI Hayes Electric Furnace Type BA 43, using Handy and Harman Easy-Flo #45 silver solder as a braze material. This material contains copper, silver, zinc and cadmium in the proportions 14, 45, 16, 24. The brazing specification is outlined in Figure 11, and the brazing fixtures are shown in Figure 12 and 13. Copper pedestals were unsatisfactory due to dissimilar expansion causing the dice to crack and a tendency to increase leakage currents in silicon devices.

Molybdenum Pedestals

Molybdenum pedestals were procured and tried. The parts were brazed in the same manner as with the copper. Molybdenum pedestals with a flash plate of copper (for good braze wetting) were first used, but even this small amount of copper under the die affected electrical characteristics enough to make it undesirable. Next, copper flashed pedestals from which the copper on the top side (the side on which the unit was mounted) was sanded off were tried, but the gold plate (plated after brazing) blistered and bubbled upon subsequent heating because of poor adhesion to the molybdenum. At this time, it was found that the braze material would wet the molybdenum even if it were not plated with copper and a sample of unplated molybdenum pedestals was brazed to unplated headers. Braze flow and wetting were excellent, but the gold plate applied after brazing blistered because of the difficulty of depositing an adherent plate of molybdenum.

Gold Plating

Two methods of surface preparation are commonly used for gold plating of molybdenum: Copper flash preplate and vapor blasting. The first is unusable in this situation. The second presents a difficulty. Vapor blasting of a part containing a glass-to-metal seal, especially a short seal length tends to weaken or destroy the hermetic seal. Therefore, it was necessary to vapor blast the moly pedestal, gold plate it, and then mount it on the header. The whole assembly was then gold plated. This approach worked with reasonable success but a less expensive procedure was desired.

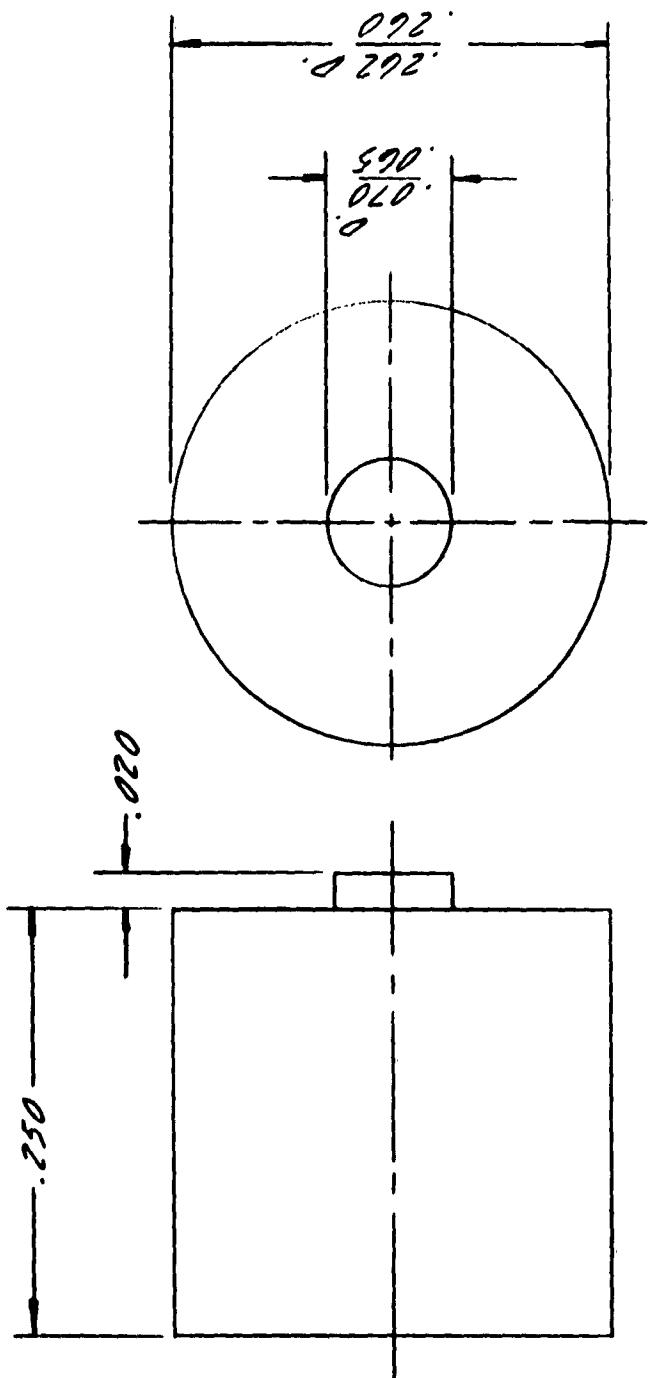
FIGURE II

FIGURE 12

MACHINING TOLERANCE UNLESS OTHERWISE NOTED			REMOVE ALL BURRS AND SHARP EDGES.	
FRACTIONAL $\pm 1/64$	DECIMAL $\pm .005$	ANGULAR $\pm 0^\circ 15'$		
<img alt="Technical drawing of a component with a central vertical slot and a top section with a diagonal cut. Dimensions include 1 1/				

FIGURE 15

MACHINING TOLERANCE UNLESS OTHERWISE NOTED			REMOVE ALL BURRS AND SHARP EDGES.	
FRACTIONAL \pm 1/64	DECIMAL \pm .005		ANGULAR \pm 0°-15'	



Powder Metal Molybdenum Pedestals

During the second quarter, the possibility of making the pedestals by powder metallurgy, rather than the then current method of stamping them out of sheet was investigated. It was felt that the powder metal pedestals would have several advantages. Since the surface was rougher, plating might be more adherent and elimination of the two-step plating process seemed a distinct possibility. Also, because of the rough surface, it was felt that the pedestals might be welded rather than brazed to the headers. Finally, it was expected that powder metal pedestals would be less expensive.

In practice, plating did show a definite improvement and the pedestals proved to be weldable to the header. Moly has too high a melting point to make a true weld; the joint produced is a very good nickel braze, the nickel being supplied by the nickel-rich, bright-dipped kovar surface. The powder-metal pedestals brought on three new problems. When the pedestals were welded to the headers after glass sealing, the welding shock cracked the glass. When the pedestals were welded to the stampings before glass sealing, they would turn black in the bright-dip that took place after sealing. Finally, the pedestals were only 96% dense, and their porosity allowed undesirable entrapments to be sealed within the transistor package.

Final Choice Pedestal

The final process consisted of B-T brazing of stamped molybdenum pedestals and two-shot gold plating.

Thermal Impedance

Measurement of thermal impedance on finished devices showed that, contrary to expectations, the units made with molybdenum pedestals had lower thermal impedance than those made without pedestals. The heat-spreading effect of the molybdenum pedestal had been greater than anticipated.

III. 3. 3 Seals and Welding

In the early part of the development, package parts received from the vendor did not conform to the print as described in Section III. 2. 2. 1.

An attempt was then made to remedy the defects in the stampings, and the changes, while solving the original problems, caused weak seals which leaked after the thermal shock of header mounting. The seals

were strengthened and the die mounting temperature curve was modified. The result of these changes was a drop in shrinkage due to leaks from 50-75% to 10-15%. An attempt to reduce this shrinkage by welding the moly pedestal into the package rather than brazing it in (brazing was done in hydrogen, and the oxide seal was reduced) failed for the reasons described in paragraph III. 3. 2. 2. Closer control of the brazing process and gradual improvements in seal quality and header mounting technique brought about a seal shrinkage rate of less than three percent.

III. 3. 4 Hermeticity

Radiflo and JAN moisture testing on 55 samples of finished devices showed one unit in 55 with a leak rate greater than 1×10^{-11} std cc/sec. This leak was 5×10^{-17} , less than that detectable by JAN moisture test. No failures occurred on JAN moisture test.

III. 4. Conclusion:

The Sylvania "Pancake" package was adapted to contain both Drift Field Germanium transistors and Silicon Mesa transistors. Leak rate of packaged devices is less than 1×10^{-11} std cc/sec. by Radiflo test on better than 98% of the completed devices. Packages readily meet the requirement of the contract to "equal or exceed" hermeticity requirements of MIL-S-19500/A. Both packages are within the limits of .070" high and .250" diameter.

APPENDIX A

ON LEGEND

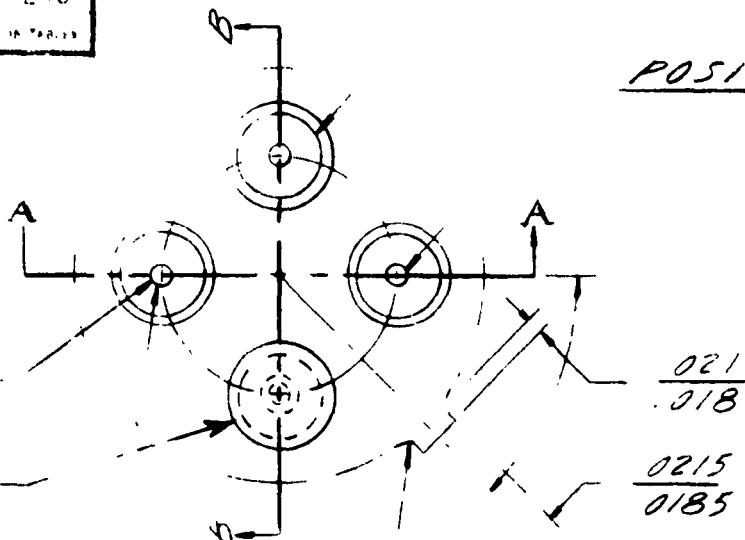
TYPE	AVL
SIZE	1/2"
NON	L TO
FINISH	NEUTRAL IN TOLERANCE

$\frac{70}{1455}$ $\frac{0.14}{0.14}$
POSITION 2

6)

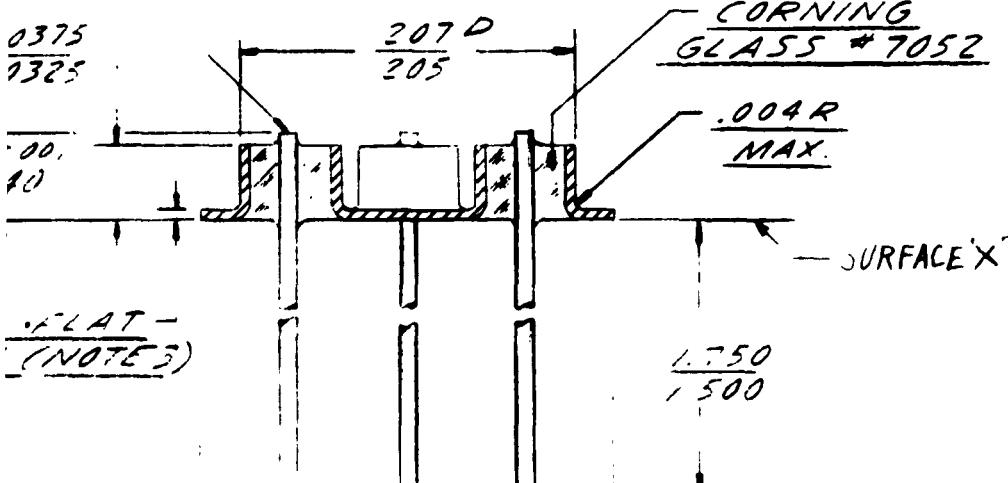
N. Q. Q.

SURFACES

POSITION 1.010R
NOM.

— NOTES: —

- *1. FINISH: BRIG
- **2. AFTER WELD
1X10-10 STD
- 3. FLANGE THICK
FALL WITHIN
- **4. CONCENTRICITY
MUST BE .002
- 5. INNER LEADS

1.750
1.500THIS PART TO BE REPLACE
BY B31-33127 P119 ON 1 MA

$\frac{0.14}{0.09}$ $\frac{.001}{.000}$ $\frac{2.60}{2.60}$
KOVAR — SECTION A-A —

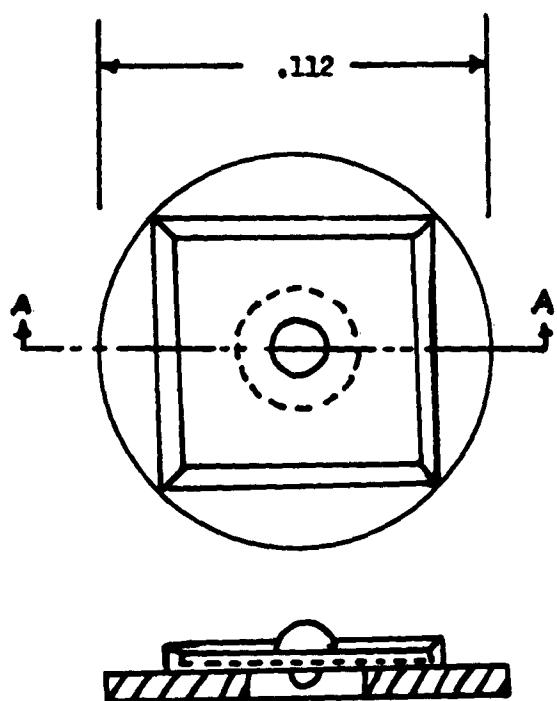
— CN'60-1834 —

115H: BRIGHT DIP
TER WELDING STEM TO CAP SEALS TO PAGE
10-10 STD CC/SEC. LEAK RATE
INGE THICKNESS OF ANY ONE PIECE MUST
L WITHIN $\pm .0005$ INCLUDING TAB
ICENTRICITY OF .207/.2050 E. 2600
ST BE .002 MAX. T.I.R.
VER LEADS TO BE SURFACE GROUND TO LENGTH

2

REQ.	DRAWING NO.	NOTE	DESCRIPTION	ITEM	NEXT ASSEMBLY
	DRAWN		FINISH		
	DESIGNED		HEAT TREAT		
	APPROVALS	DATE	MATERIAL		SCLEAR
	DESIGN		EQUIP.		
	CHECKED	STM 60	PART	HEAT TREAT	
ONE EACH MOMO	DRAWN	5			
	REV'D TO	100			
	SCALE	10X	SYLVANIA	ELEC. PROD., INC. SEMICONDUCTOR DIVISION	B31- 111- 5114

FIGURE A-2



Section AA

ALLOY SUBASSEMBLY

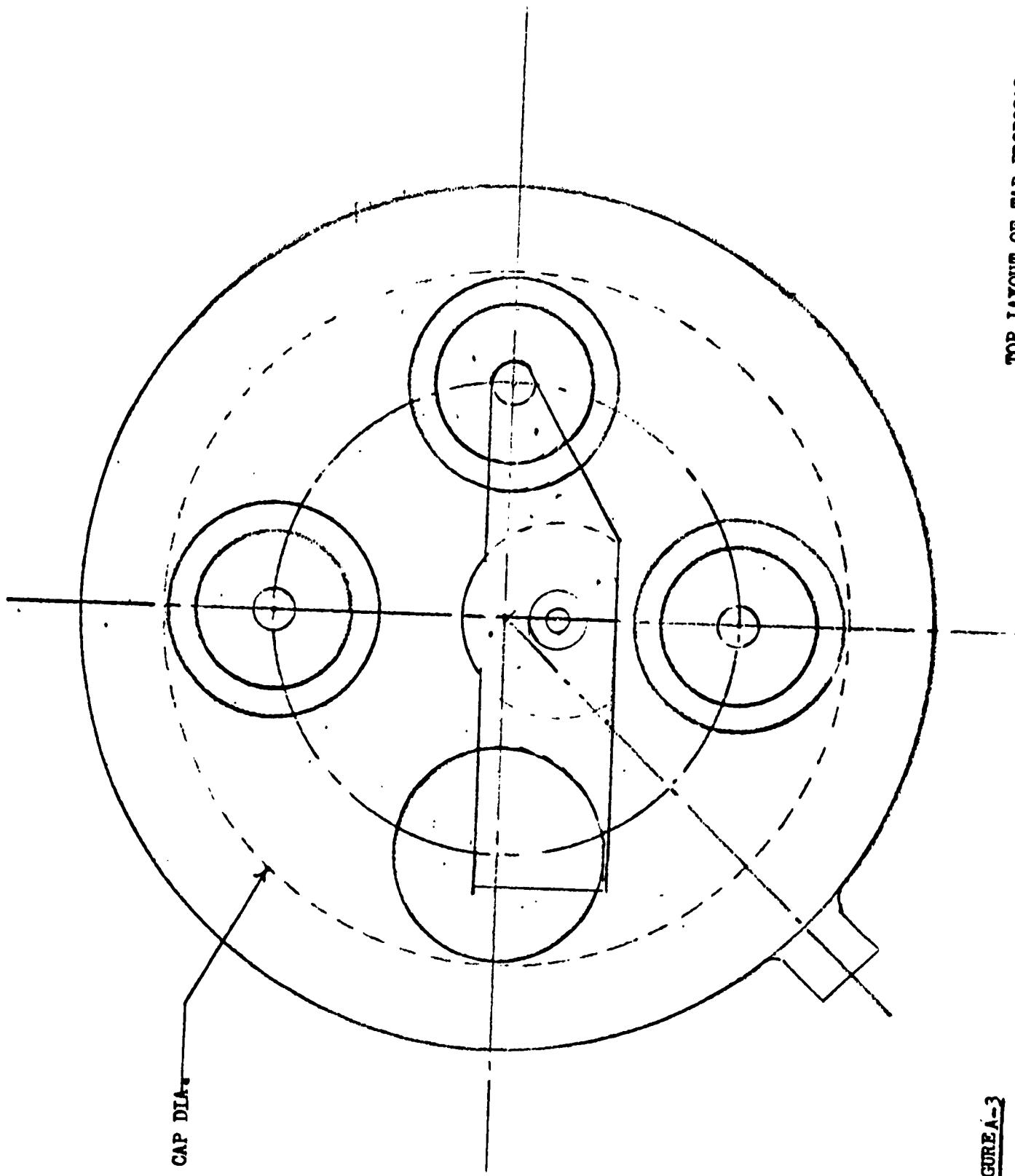
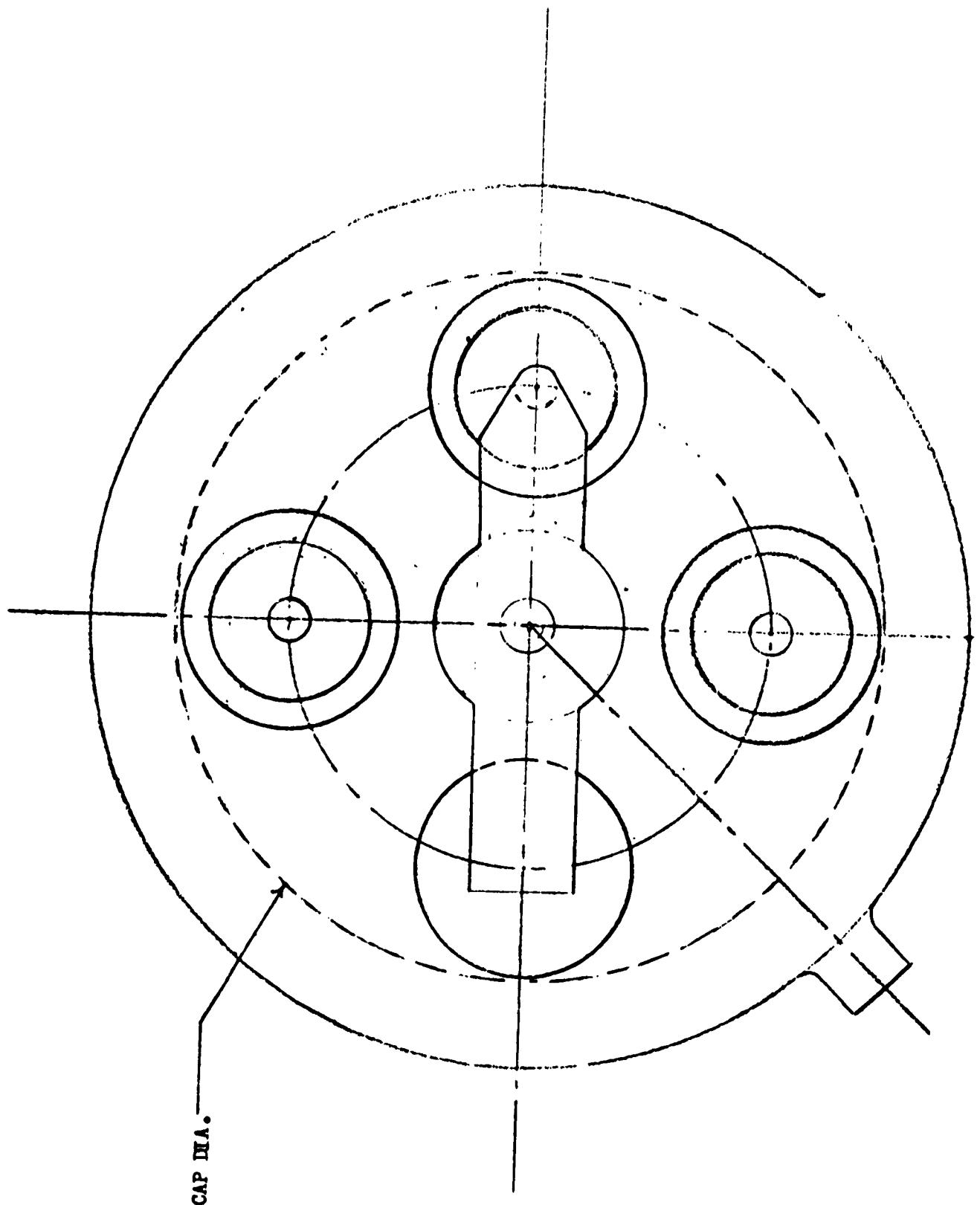


FIGURE A-3

FIGURE A-4



MACHINING TOLERANCE UNLESS OTHERWISE NOTED				WORK TO DIMENSIONS AND REPORT ERRORS COMBINATIONS OF DIMENSIONS MUST BE HELD WITHIN TOLERANCE	DATE ISSUED	S. O.
FRACTIONS \pm	DECIMALS $\pm .005$	HOLE $\frac{1}{2}$ TO HOLE $\frac{1}{2}$ \pm —				
$\frac{1}{64}$	$\pm .005$					

NOTES. —

1. SURFACE 'A' TO BE FLAT WITHIN .0005
2. MAX. BURR IN HOLE TO .05-.001
3. BURR TO BE DIRECTIONAL →
4. TAB TO BE STREET OR WRINKLED
TOOL MARKS.

MACHINING TOHRANE UNLESS OTHERWISE NOTED

WORK TO DIMINISH AND REPORT ERRORS

COMBINATIONS OF DIMENSIONS MUST BE HELD WITHIN TOLERANCE

DATE ISSUED

10

10

20

卷之三

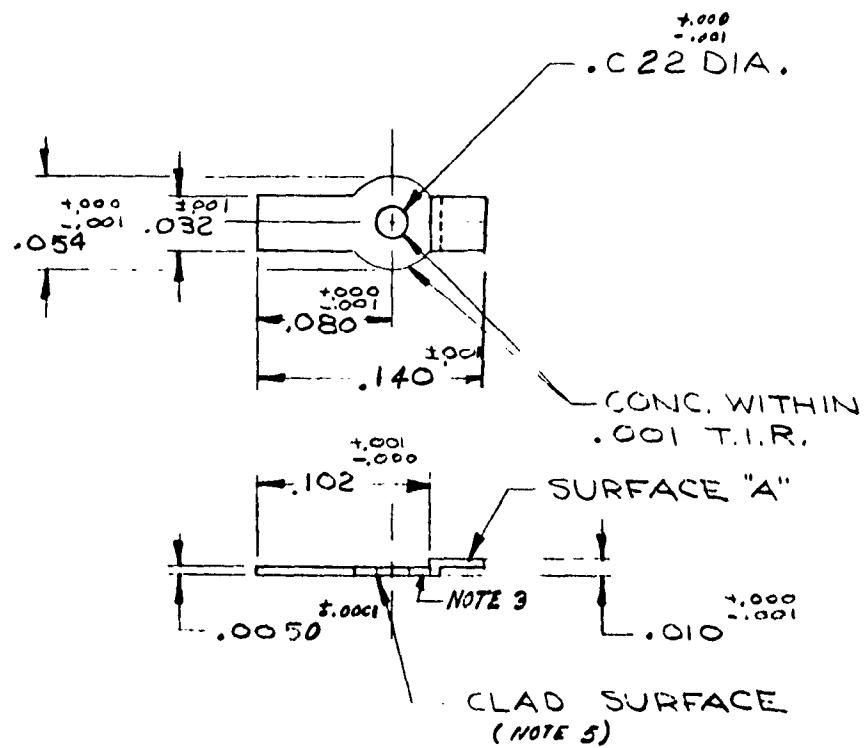
二二〇

A technical drawing of a mechanical assembly. It features a central circular hole with a diameter of 0.32. A vertical line passes through the center of the hole. To the left, a vertical line is labeled with dimensions 0.002, 0.032, 0.054, and 0.002 from top to bottom. To the right, a vertical line is labeled with 0.001, 0.001, and 0.001 from top to bottom. A horizontal line at the bottom is labeled 11/11. A diagonal line from the top left to the bottom right is labeled 60°. A horizontal line at the top is labeled 60°.

CONC WITH
.001 T.I.R.

SURFACE A:

A technical drawing showing a stepped surface profile. The profile starts at a base level of -0.02 with a tolerance of $+0.001$ to -0.000 . It rises to a first step of -0.005 with a tolerance of $+0.001$ to -0.000 . From this step, it rises to a second step of -0.001 with a tolerance of $+0.001$ to -0.000 . The final surface is labeled CLAD SURFACE.

NOTES:

1. SURFACE "A" TO BE FLAT WITHIN .0005.
 2. MAX BURR IN HOLE TO BE .001 MAX.
 3. THIS SURFACE TO BE FREE FROM BURRS.
 4. TAB TO BE FREE OF WRINKLES AND
 TOOL MARKS
 5. 60/40 TIN-LEAD CLAD, $.0005^{+.0002}_{-.0003}$ THICK ON ONE
 SIDE.

COPIES
TO

D-1

6 P	CN61-6111, 26 SLPY 6, 1850 ft 6 100 wns, 160 rev.	B
1850 ft 6 100 wns, 160 rev.	CN61-5878	A

APPR'D REVISIONS LTR.

ALL DIMENSIONS UNLESS OTHERWISE SPECIFIED ARE IN INCHES
 WITH TOLERANCES OF:
 FRACTIONAL $\pm 1/64$
 DECIMAL $\pm .005$
 ANGULAR $\pm 1/2^\circ$

MATERIAL: GRADE A NICKEL, $.0050^{+.0001}_{-.0003}$ T.H.C.SYLVANIA ELECTRIC PRODUCTS, INC.
SEMICONDUCTOR DIVISION PLANT - WOBURN

TITLE:

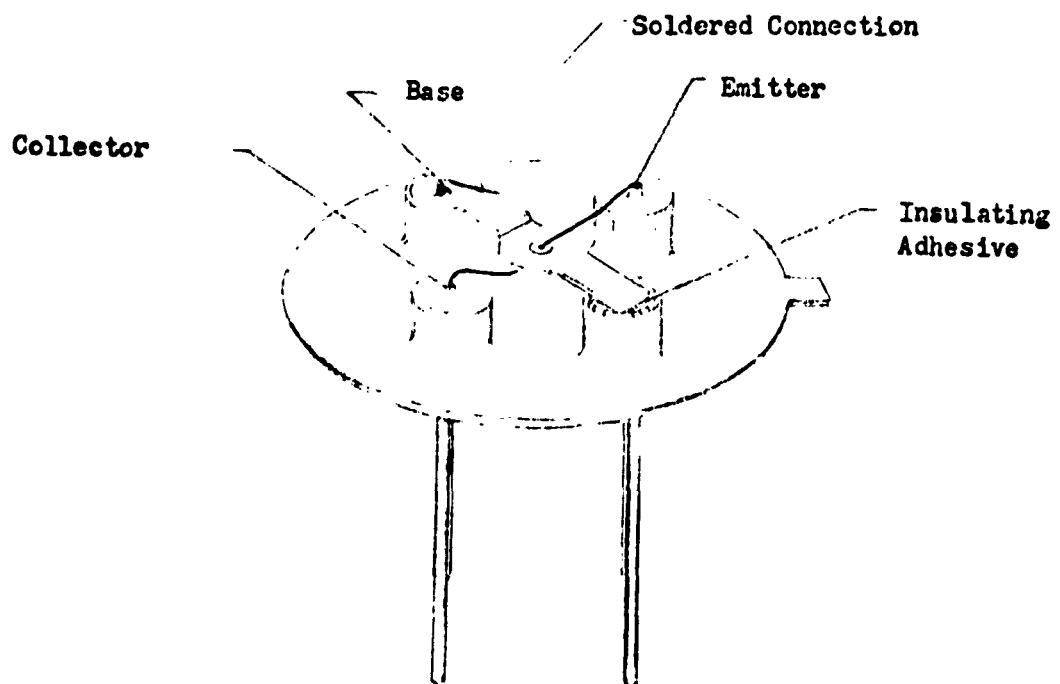
TAB

DRAWN BY: BRAYMAN 1/3/64 DATE: 10/1
APPR'D DESIGN DATE: APP'D PROD. DATE: 1/21/64

REV. LTR. B

A31 33514P68 B

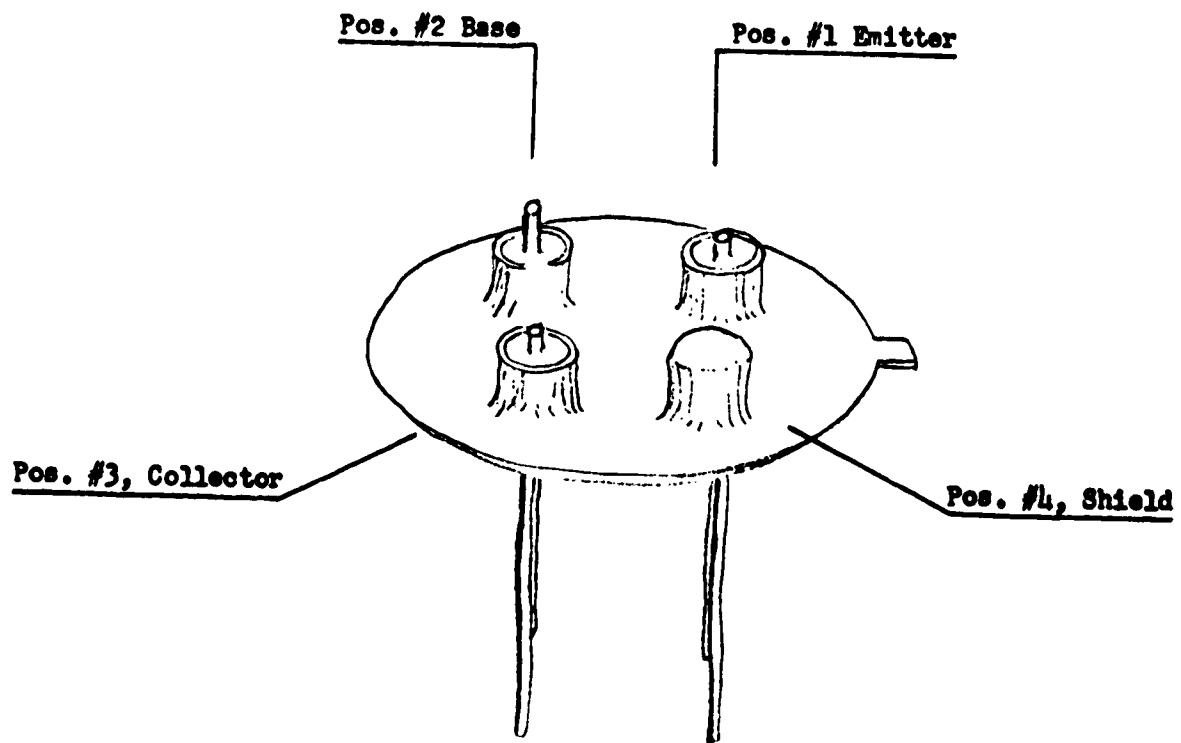
FIGURE A-7



GENERAL INTERNAL CONSTRUCTION OF
MICROMINIATURE DRIFT FIELD DEVICE

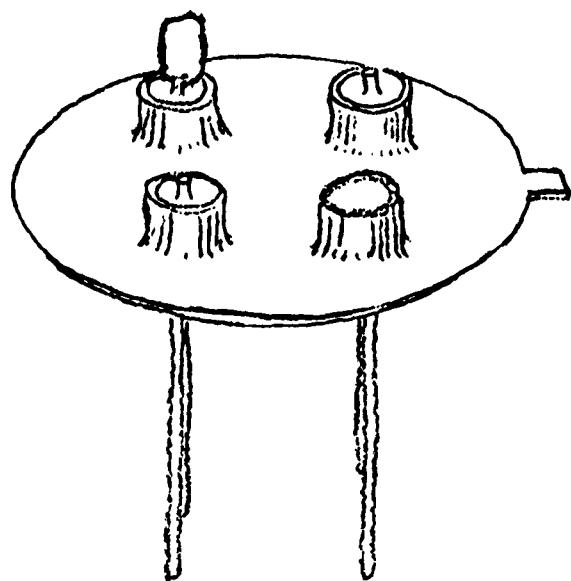
APPENDIX B

HEADER AS SUPPLIED BY VENDOR



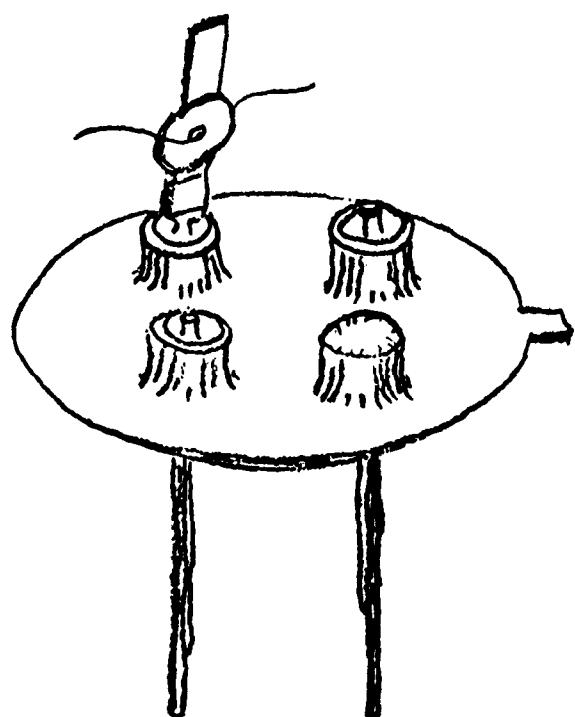
MICROMINIATURE DRIFT FIELD, FIGURE # B-1

HEADER WITH SECONDARY OPERATION
OF LEAD CUTTING & FLATTENING



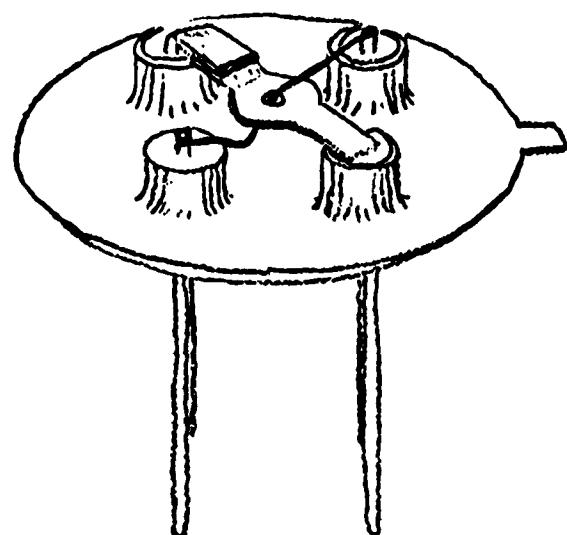
MICROMINIATURE DRIFT FIELD, FIGURE # B-2

ALLOYED SUBASSEMBLY WELDED TO HEADER



MICROMINIATURE DRIFT FIELD, FIGURE # B-3

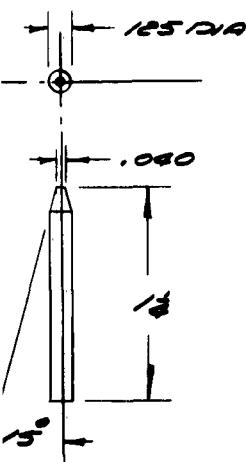
WELDED AND ADJUSTED DEVICE & HEADER ASSEMBLY



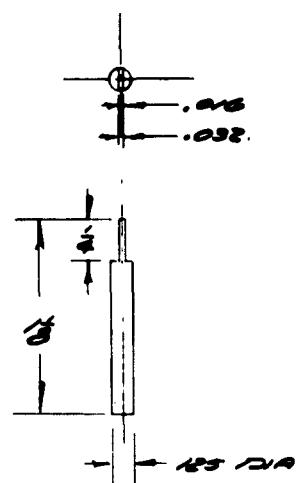
MICROMINIATURE DRIFT FIELD, FIGURE # B-4

FIGURE B-5

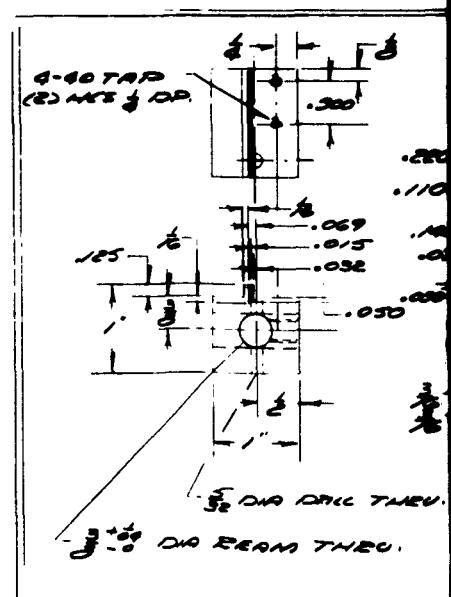
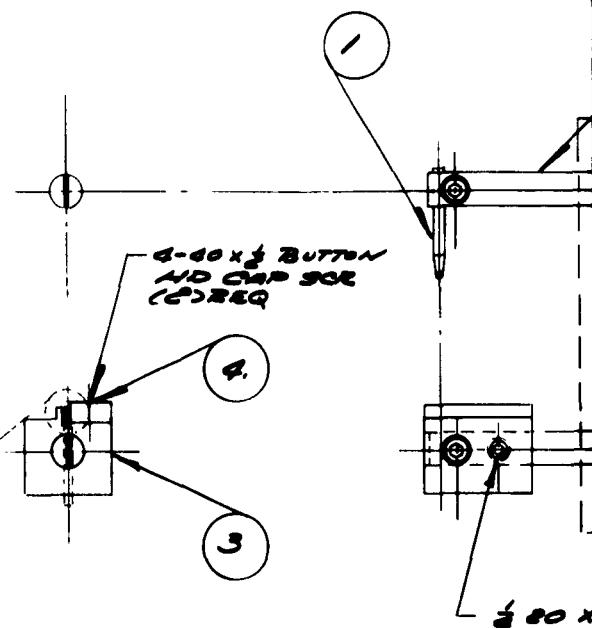
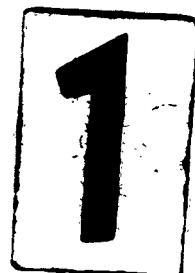
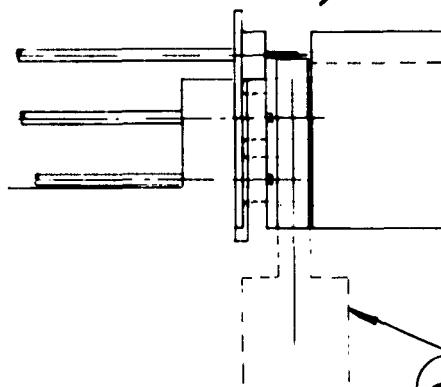
MOT ZIETUNG
(C)REQ.



MOT ZIETUNG
(C)REQ.



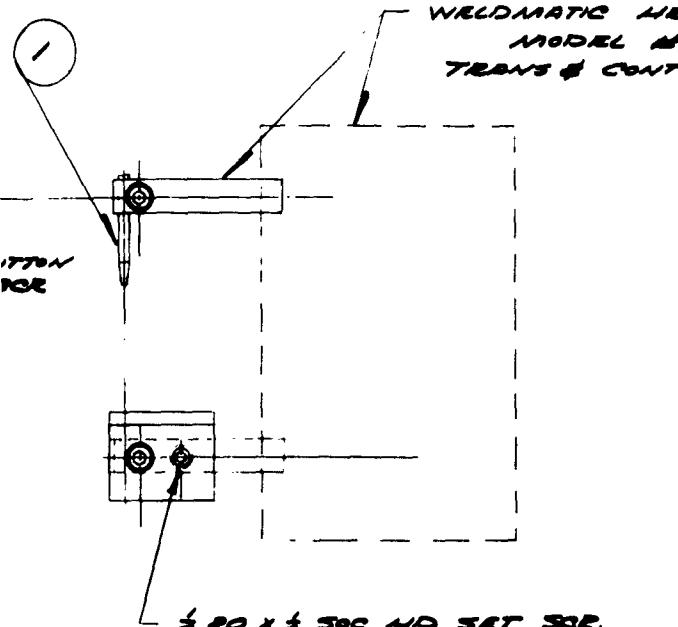
SIDE 10X.



MACHINING TOLERANCE UNLESS OTHERWISE NOTED
FRACTIONAL ± 1/64 DECIMAL ± .008 ANGULAR ± 0°-15'

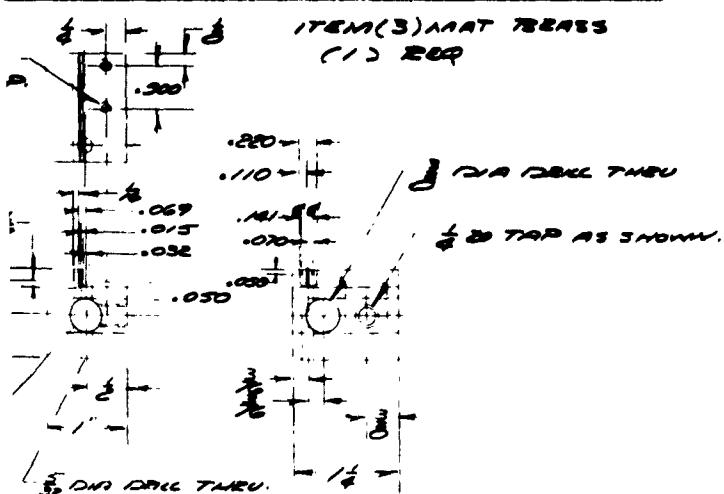
REMOVE ALL BURRS
AND SHARP EDGES.

WELDMATIC HEAD
MODEL # 10223
TRANS & CONTROL. 10160.



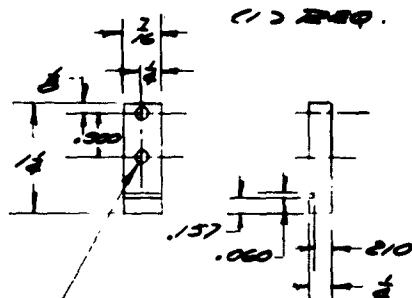
2

1/80 x 3/32 IN. ID SET SOR.



10 REAM THRU.

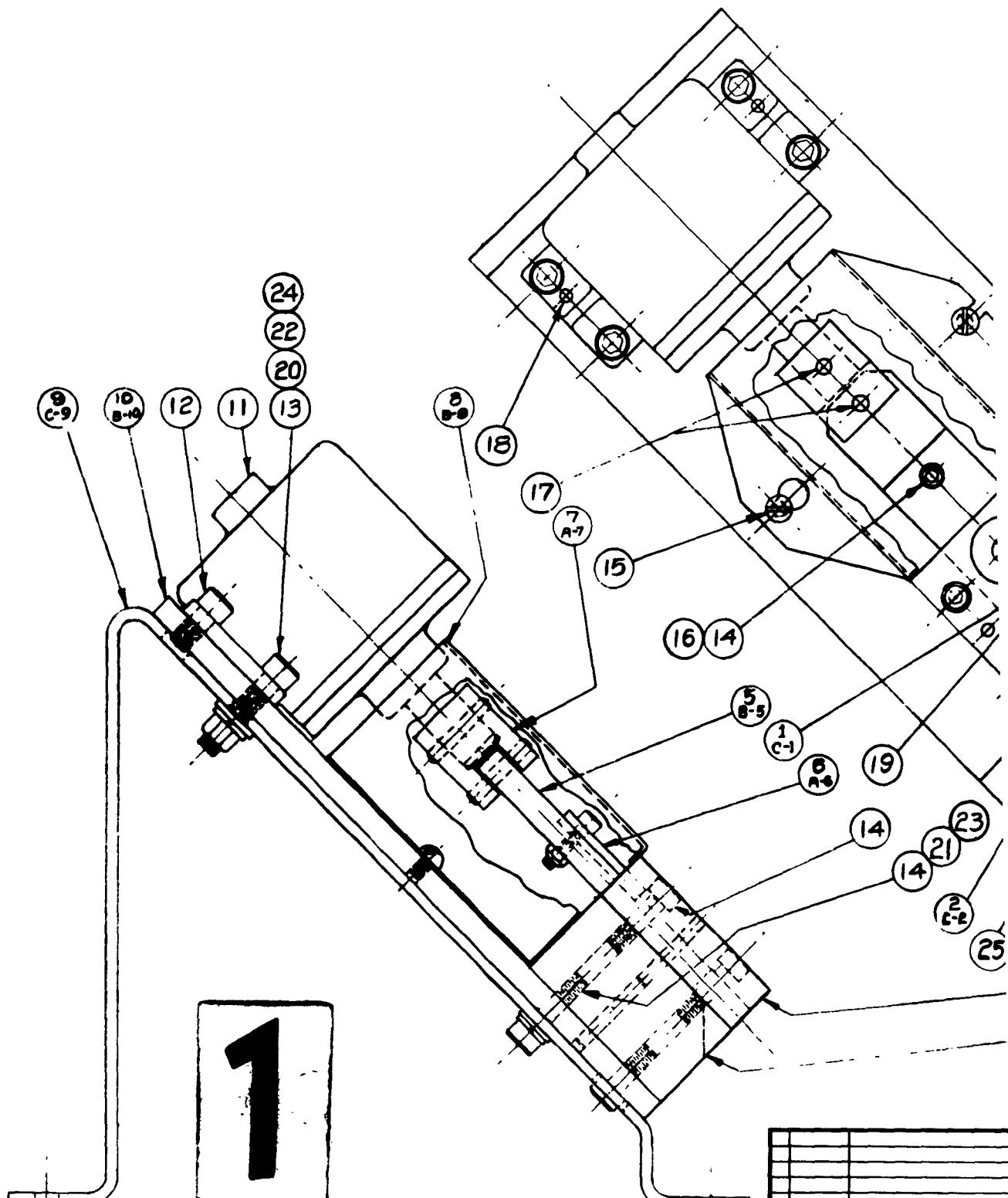
ITEM (2) MATT BEARSS.
(1) EOD



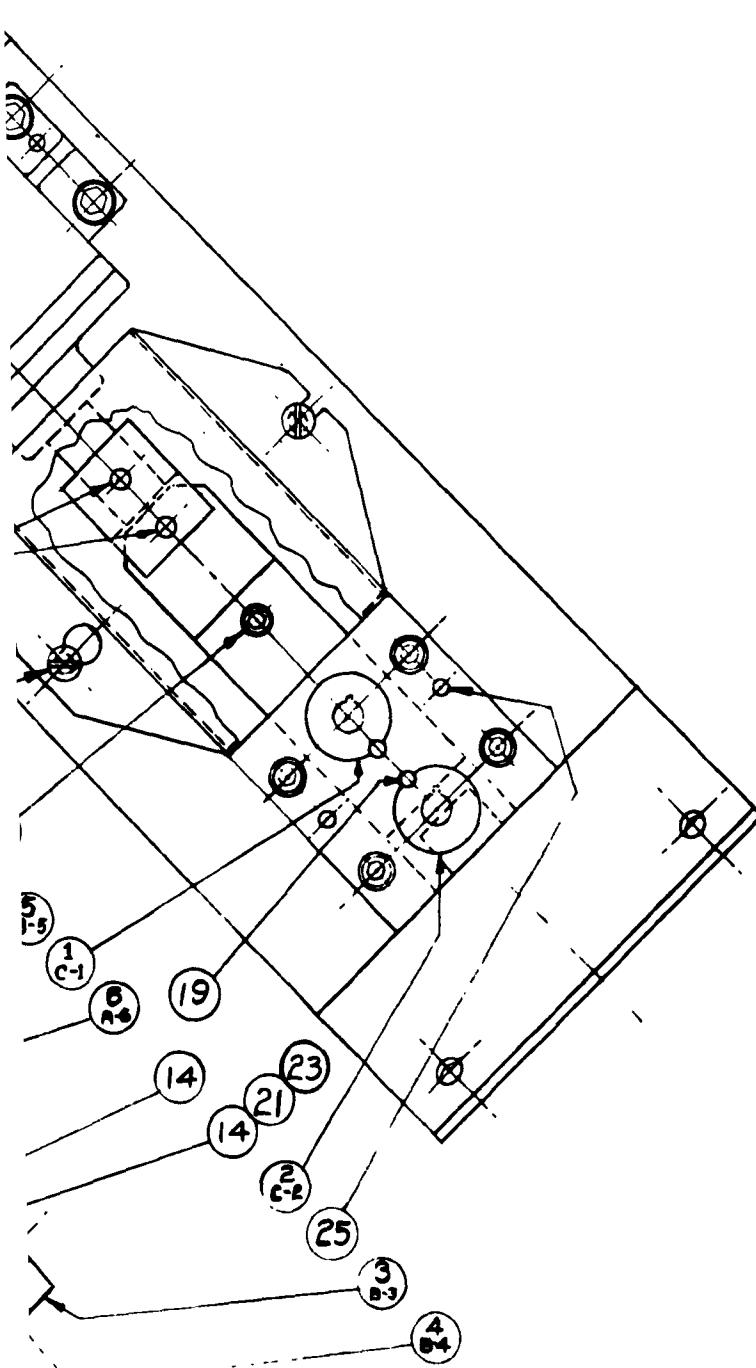
MODEL NO.				
REFERENCE				
DRW APPRO'D				MATT
PROD APPRO'D	REQ'D	LST DWS NO.	ITEM	REMARKS
			MATT LIST	
DRAWN D. PLANT CHECKED	DATE 4/16/81	SYLVANIA	ELEC. PROD. INC. Sylvania Division	D 31-41895-A1

FIGURE B-6

MARK DRAWING NO
ON PART



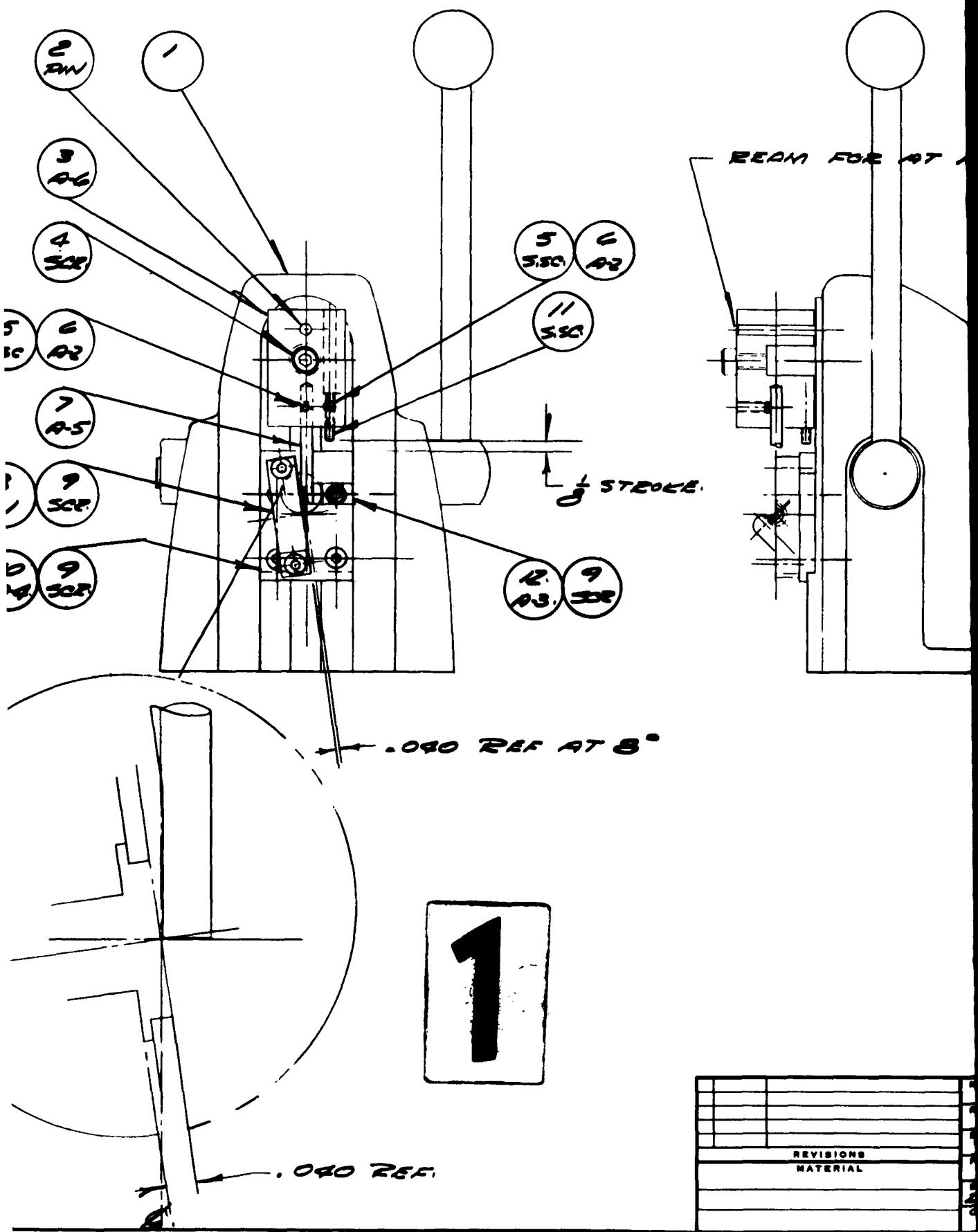
MACHINING TOLERANCE UNLESS OTHERWISE NOTED			REMOVE ALL BURRS AND SHARP EDGES.	
FRACTIONAL $\pm \frac{1}{64}$	DECIMAL $\pm .005$	ANGULAR $\pm 0^\circ 15'$		



	MODEL NO.					
	REFERENCE					
	DES. APP'R'D					
	PROD. APP'R'D	REQ'D	LIST DWG. NO.	ITEM	MAT'L LIST	REMARKS
REVISIONS MATERIAL	EQUIPMENT	Y1				
DRAWN CHECKED	PART	DRIFT FIELD PANCAKE P'K'G. CUT-OFF & SWAGE TOOL ASSEMB.				
	FULL SIZE	SYLVANIA ELEC. PROD. INC. SEMICONDUCTOR DIVISION				
	DATE:-	C31-43505-A1				

2

FIGURE B-1

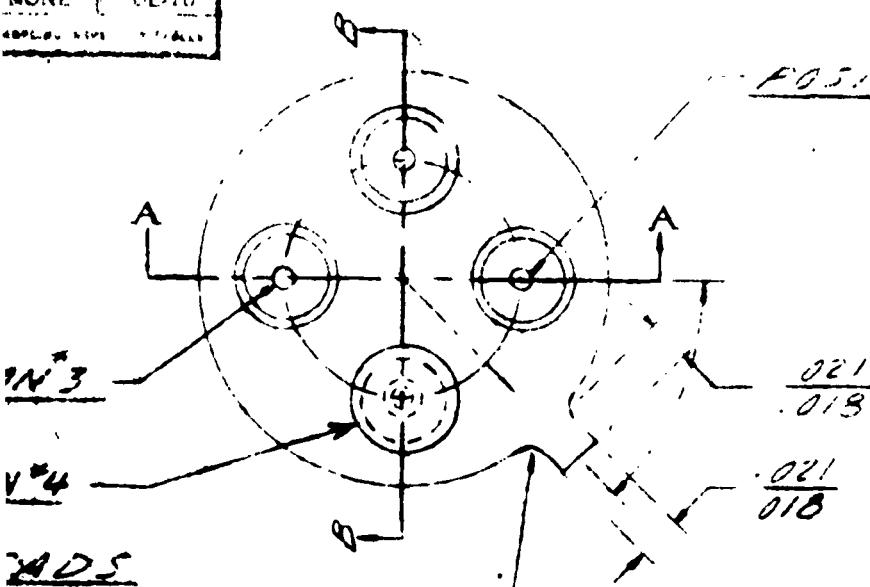


APPENDIX C

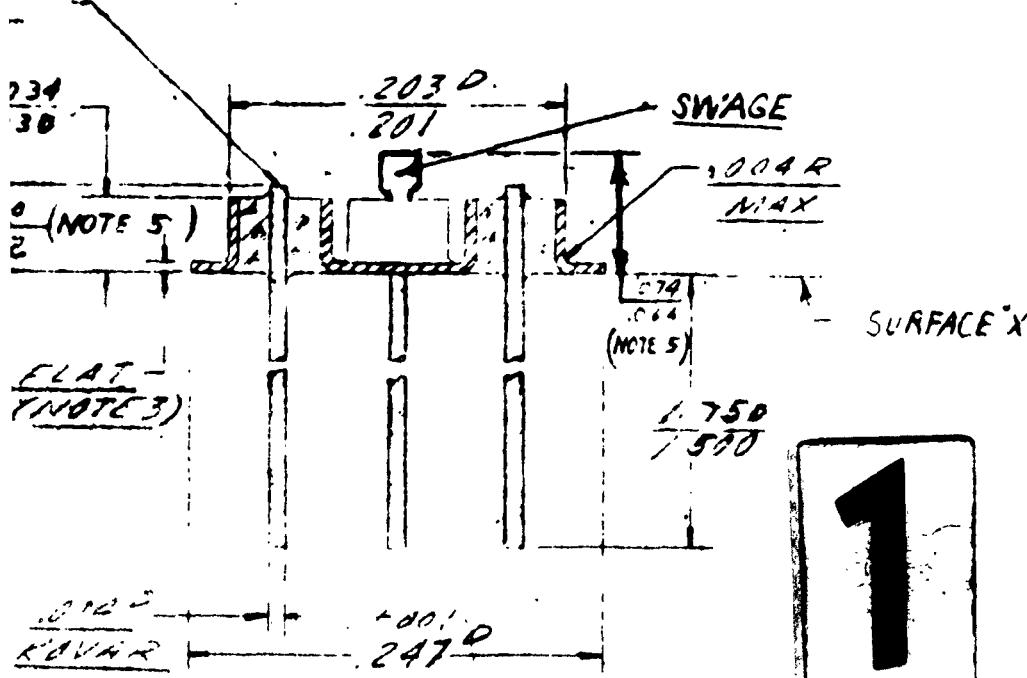
PART I

Subassembly and Part Drawings

NON-LEGEND	
SYMBOL	SAMPLE NO. 4
••	DL-5
*	DL-7
NONE	DL-10
APPROV. SIGN	MAN



IN 3
V 4
ADS
 $141 \pm .002$ PC WITHIN
 \pm TRUE POSITION IN
 \pm CT TO 247.06 TAB
 \pm MEASURE UNSURFACE 'X'

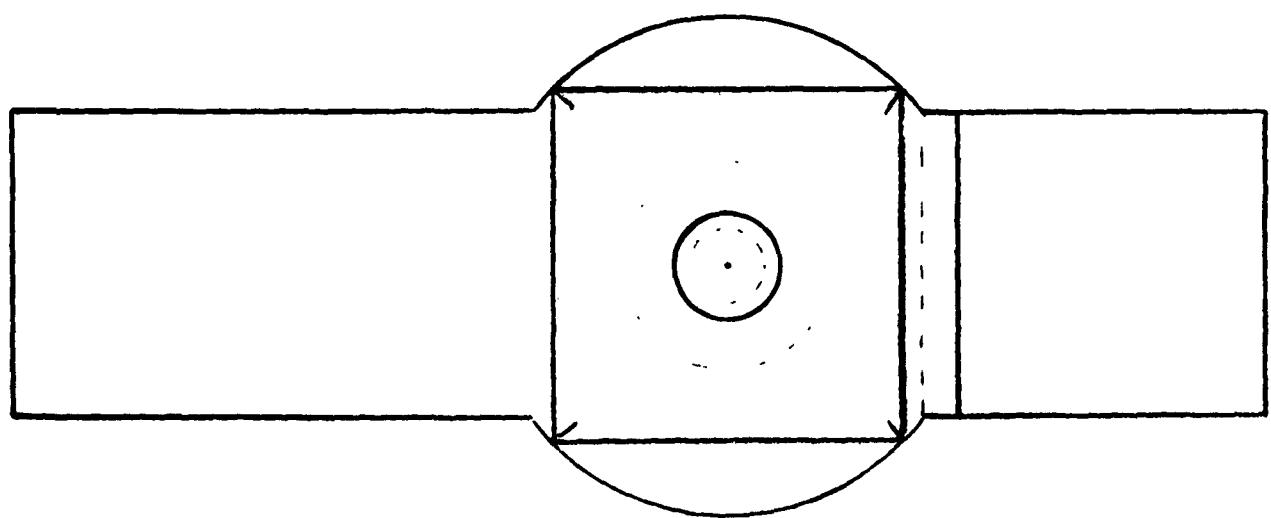
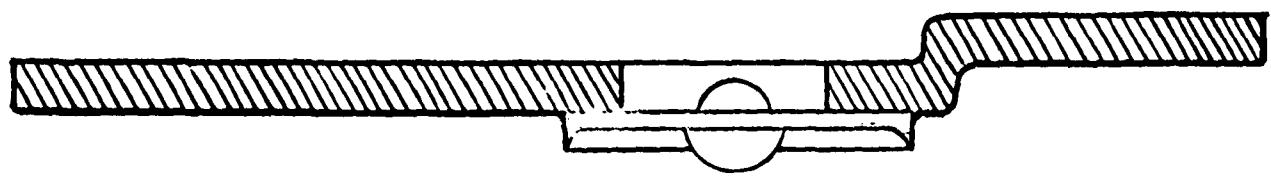
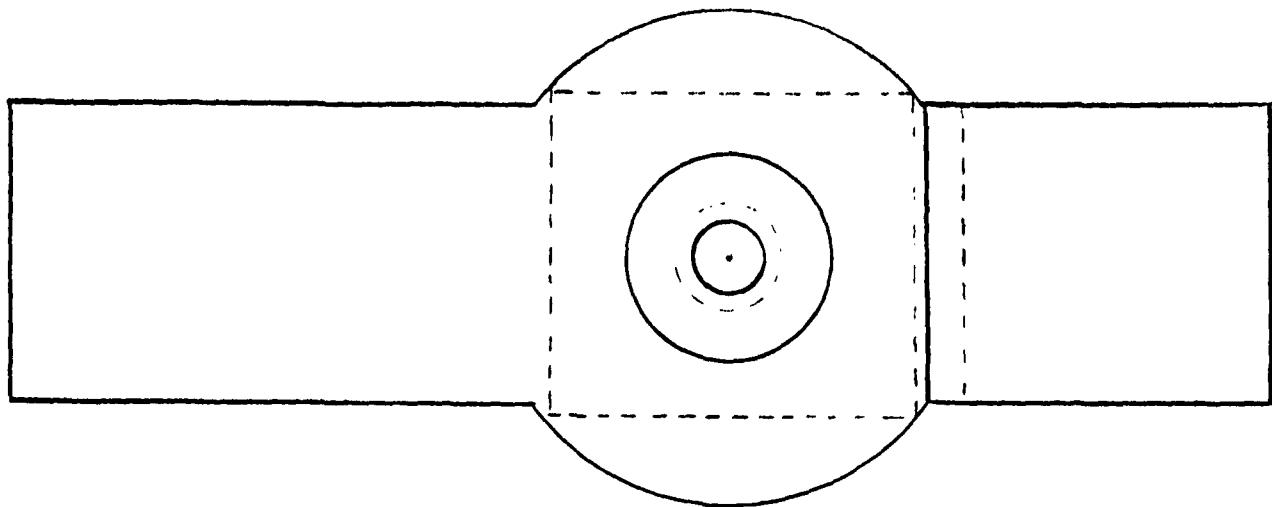


B. NO GLABS
 WELD AREA
 SURFACES
 9. SURFACE 'X' TO B
 WITHIN .002
 10. LEADS MUST MEET END TO
 PER SYLVANIA SPEC: CON-109

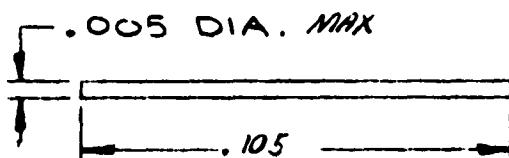
— NOTES: —
 1. FINISH: BR
 2. AFTER WELD
 IX.0 \pm .010
 3. FLANGE THI
 FALL WITHIN
 4. CONCENTRIC
 MUST BE .00
 5. THE .050/.042 DIM. AP
 6. WELDED LEAD
 HEADED WIRE
 LEAD WELD
 THAN .001 OR
 7. MAX. TAPER
 SIZES OF EYE
 8. EMBODIMENT
 EYE 2°

EN 60-4300 —

MACHINING TOLERANCE UNLESS OTHERWISE NOTED			REMOVED BY SHARP EDGES																																											
FRACTIONAL $\pm \frac{1}{64}$	DECIMAL $\pm .005$	ANGULAR $\pm 0^\circ 10'$																																												
<p>NO GLABS - 41.4R CH Particles shall be in the weld area including both top & bottom flange surfaces</p> <p>MEET EEND TEST SPEC: CEN-179</p>			<p>REVISIONS</p> <p>A) NEW CLASSIFICATION SPATTER ADDED CNGO-5220 1/13/61</p> <p>B) ADDED MEASURE ON SURFACE X CNGI-1152 2-27-61</p> <p>C) REVISED PER CNGI-4914 7-19-61</p> <p>D) ADDED NOTE 58 DIM. CNGI-4990 3-14-61</p> <p>E) ADDED NOTE TO CNGI-5753 12-SEPT-61</p>																																											
<p>ESI -</p> <p><u>1.154: BRIGHT DIP</u> <u>TER WELDING STEM TO CAP SEALS TO PASS</u> <u>.0004 TO CC JCC. (A AIR LEAK RATE)</u> <u>ENGE THICKNESS OF ANY ONE PIECE MUST</u> <u>BE WITHIN $\pm .0005$ INCLUDING TAB</u> <u>CENTRICITY OF .203/.2010 F. 7370</u> <u>ST BE .002 MAX T.I.R</u> <u>.050/.042 DIM. APPLIES TO BOTH LEADS 1 AND 3. THE .074/.066 DIM. APPLIES ONLY TO LEAD 2</u> <u>LEAD MUST BE TIGHTLY WELDED USING</u> <u>WIRE & THE SURFACE OPPOSITE THE</u> <u>WELD SHOULD NOT BE UNWELDED MORE</u> <u>THAN .001 OR VISIBLE DISFIGURED</u></p> <p>2</p>																																														
<table border="1"> <thead> <tr> <th>REF.</th> <th>DRAWING NO.</th> <th>NOTE</th> <th>DESCRIPTION</th> <th>ITEM</th> <th>NEXT ASSEMBLY</th> </tr> </thead> <tbody> <tr> <td rowspan="7">4300</td> <td>DRAWN</td> <td></td> <td>FINISH</td> <td></td> <td></td> </tr> <tr> <td>RECORDED</td> <td></td> <td>HEAT TREAT</td> <td></td> <td></td> </tr> <tr> <td>APPROVALS</td> <td>DATE</td> <td>MATERIAL</td> <td></td> <td></td> </tr> <tr> <td>DESIGN</td> <td></td> <td>EQUIP.</td> <td></td> <td></td> </tr> <tr> <td>CHECKED</td> <td>TM</td> <td>PART</td> <td>WELDER</td> <td>MM 2N 389</td> </tr> <tr> <td>DRAWN</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>SCALE</td> <td>.0X</td> <td>SYLVANIA</td> <td>ELEC. PROD., INC. SEMICONDUCTOR DIVISION</td> <td>B31-33127P10</td> </tr> </tbody> </table>					REF.	DRAWING NO.	NOTE	DESCRIPTION	ITEM	NEXT ASSEMBLY	4300	DRAWN		FINISH			RECORDED		HEAT TREAT			APPROVALS	DATE	MATERIAL			DESIGN		EQUIP.			CHECKED	TM	PART	WELDER	MM 2N 389	DRAWN					SCALE	.0X	SYLVANIA	ELEC. PROD., INC. SEMICONDUCTOR DIVISION	B31-33127P10
REF.	DRAWING NO.	NOTE	DESCRIPTION	ITEM	NEXT ASSEMBLY																																									
4300	DRAWN		FINISH																																											
	RECORDED		HEAT TREAT																																											
	APPROVALS	DATE	MATERIAL																																											
	DESIGN		EQUIP.																																											
	CHECKED	TM	PART	WELDER	MM 2N 389																																									
	DRAWN																																													
	SCALE	.0X	SYLVANIA	ELEC. PROD., INC. SEMICONDUCTOR DIVISION	B31-33127P10																																									



ALLOYED DICE & BASE TAB ASSEMBLY

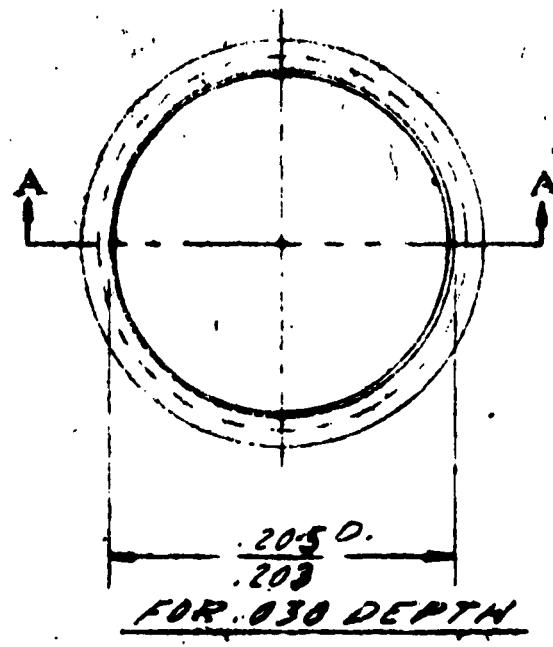


* MAT'L. ^{+.0001}
 DEAD SOFT .0040 DIA. COPPER,
 TIN PLATED TO .005 DIA. MAX

COPIES
TO

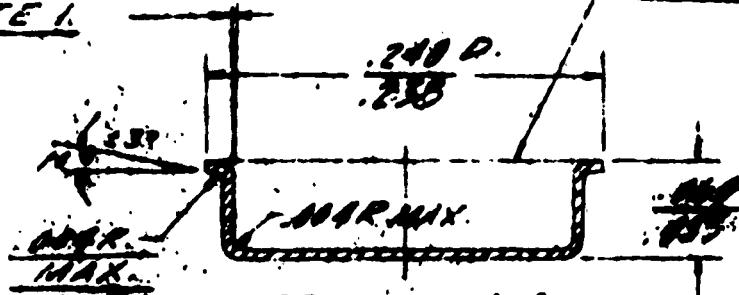
D-1

APPR'D	REVISIONS	LTR.	CN61-5876	MATERIAL: *	DRAWN BY: 11/11/71	DATE: 11/11/71	SCALE: 20:1
ALL DIMENSIONS UNLESS OTHERWISE SPECIFIED ARE IN INCHES WITH TOLERANCES OF:			SYLVANIA ELECTRIC PRODUCTS, INC.				
FRACTIONAL \pm 1/64			SEMICONDUCTOR DIVISION PLANT-WOBURN				
DECIMAL \pm .003			TITLE: LEAD				
ANGULAR \pm 1/2°			SIZE CODE: A31		APPR'D DESIGN DATE: 6/13/71		APPR'D PROD DATE: 11/11/71
							REV. LTR: P85



NOTE 1.

NOTE 5



SECTION A-A

NOTES

1. 1.0 MAX. TAPER INSIDE OF
2. BODY TO FLANGE EXCENT. PRO
3. MAX. T.L.
4. THICKNESS OF FLANGE MAY
5. VARY MORE THAN .0005
6. PART TO BE CLEANED BY FIR
7. HYDROGEN ATMOSPHERE FOR
8. AT 950°C FOR 20 MIN. KEEP
9. SURROUNDED BY GAS TO 200°C
10. IN AIR-TIGHT CONTAINERS
11. STILL AS HOT AS PRACTICABLE
12. FLANGE TO BE FLAT WITHIN
13. 1/16" FACE FREE OF BURRS.

SDM 18 APR 1961	205 203 WAS 202 CNC-1-2319 4-19-61	B
SDM	204/203 WAS 200/203 CNC-1-2300 4-19-61	A

APPROD REVISIONS LTR

ALL DIMENSIONS UNLESS OTHERWISE SPECIFIED ARE IN INCHES
WITH TOLERANCES OF:

FRACTIONAL $\pm 1/64$

DECIMAL $\pm .005$

ANGULAR $\pm 1/2^\circ$

DEFIANCE NO. 8000H 85268

C-N-61-4304 MATERIAL: 40 1010 CRS. C
DRAWN: W. J. H.
SYLVANIA ELECTRIC PRODUCTS, INC.
SEMICONDUCTOR DIVISION PLANT: WICHITA

TITLE:

CAP

SIZE CODE

A31

PART II

Process Specifications

TAB WELDING (TF50-1)

1.0 Equipment

- 1. 1 Locating jig - Dwg. #D31-41495-A1
- 1. 2 Weldmatic Power unit #1016C
- 1. 3 Weldmatic Weldinghead #1032
- 1. 4 Magnifying Glass and Lamp (Fisher Scientific Cat. #12-0710)
- 1. 5 Tweezers (Genuine Hub #5)
- 1. 6 Holding trays

2.0 Materials

- 2. 1 Tabbed alloyed subassembly
- 2. 2 Base header assembly (Dwg. # B31-33129P119)
- 2. 3 Bibulous paper (Central Scientific #66200)

3.0 Procedure

- 3. 1 Pre-set power unit to deliver four (4) watt seconds.
- 3. 2 Position tabbed alloy assembly on locating jig.
- 3. 3 Insert header assembly into locating jig.
- 3. 4 Depress foot pedal attached to welding head.
- 3. 5 Remove welded subassembly from fixture and place in holding tray.
Hold for subsequent operations in suitable storage area.

4.0 Quality

- 4. 1 Weld pressure setting to be determined by line Engineer and/or Technician. Welding operation must not be performed without the daily consent of either of the above (Engr. and/or Tech.).
- 4. 2 Samples are to be taken at regular intervals during operation and examined by Line Engineer and/or Technician for mechanical strength.

HEADER ADJUST (TF50-2)

1.0 Equipment

- 1.1 Microscope (American Optical Cycloptic 10x Paired Eye Piece plus F3 objective lens) Model #359.
- 1.2 Soldering Iron (Unger Electric Tool Inc.) with soldering head part #1235
- 1.3 Stainless steel tweezers (Genuine Hub #5)
- 1.4 Filament cutters (Genuine Dumont #15A)
- 1.5 Stainless steel wire basket, 3" wide x 7" long x 1" high (#30 Mesh)
- 1.6 Pyrex dish (#213B20, 1 1/2 quarts)
- 1.7 Tooth picks
- 1.8 Adjust jig
- 1.9 Dry Box (-20°F Dewpoint, max.)
- 1.10 Drying oven with dry N₂ feed
- 1.11 Bending fixture- Dwg. #C31-43517-A1

2.0 Materials

- 2.1 Alloyed subassembly welded in accordance with TF50-1 to header - Dwg. # B31-33127P)
- 2.2 Emitter connecting wire
- 2.3 Collector connecting wire
- 2.4 Neutro #14 flux
- 2.5 Hot running demineralized water supply

3.0 Procedure

- 3.1 Preheat soldering iron.
- 3.2 Preheat drying oven to 100°C ± 5°C.
- 3.3 Fill pyrex dish with running demineralized water - keep a continuous flow into dish which is approximately equal to or greater than one liter/ minute.
- 3.4 Insert header assembly in adjust jig.
- 3.5 Flux collector dot and lead wire with the aid of a toothpick, connect lead to dot by soldering.
- 3.6 Remove assembly from jig.

Header Adjust (TF50-2) continued

- 3.7 Insert assembly into bending jig and bend in accordance with TF50-3.
- 3.8 Remove assembly from bending jig and insert in adjust jig.
- 3.9 Preflux emitter dot and header pin designated as the emitter lead.
- 3.10 Solder an emitter connecting wire to the emitter lead.
- 3.11 Connect the opposite end of this emitter connecting wire to the emitter dot. Clip off any excess wire with the aid of supplied filament cutters.
- 3.12 Preflux the header pin designated as the collector lead.
- 3.13 Connect the loose end of the collector lead wire to the collect lead of header.
- 3.14 Remove assembly from adjust fixture and immerse in pyrex dish containing running demineralized water.
- 3.15 Allow unit to rinse for a minimum of 15 minutes.
- 3.16 Transfer rinsed units into preheated oven and allow to dry for 30 minutes minimum.

4.0 Quality

- 4.1 The purity of the rinse water is to be greater than two (2) megohms. All units washed in any rinse water with a purity less than designated are to be Sparkleen cleaned and rewashed in accordance with item 3.15.
- 4.2 The temperature of the rinse water is to be a minimum of 60°C, and a maximum of 90°C. Water temperatures which differ from that designated are not to be used. Units inadvertently washed with water which does not meet specified requirements are to be reworked in accordance with item 4.1.

TAB BEND (TF50-3)

1.0 Equipment

1.1 Bending jig - Dwg. # C31-43517-A1

1.2 Storage trays

2.0 Materials

2.1 Header with attached subassembly

2.2 Finger cots

3.0 Procedure

3.1 Insert assembly into bending jig.

3.2 Pull lever down to "Stop" and release.

3.3 Remove subassembly from jig and place in tray.

4.0 Quality

4.1 Finger cots are to be worn while handling units. Rewash all units handled otherwise for a period not less than 15 minutes in deionized water (purity > 2 megohms).

4.2 "Stop and Release" setting to be set by Line Engineer or Technician only.

PRE-TEST (TF50-4)

1.0 Equipment

- 1.1 Tektronix transistor curve tracer #575.
- 1.2 Class 40 base test socket.
- 1.3 Dry box (-20°F Max. Dewpoint).

2.0 Materials

- 2.1 Etched, washed and dried SYL-993.

3.0 Procedure

- 3.1 Turn power switch of curve tracer on.
- 3.2 Set peak volt range switch to 0 - 200 V position.
- 3.3 Set polarity switch to PNP position.
- 3.4 Set vertical current select dial to 0.1 MA position.
- 3.5 Set horizontal voltage select dial to "Collector Volts" 10 position.
- 3.6 Set base step generator to plus (+) position.
- 3.7 Plug in test socket collector and base leads to appropriate binding posts of scope. (For simplicity, use transistor B side and set transistor selector to Transistor B).
- 3.8 Turn intensity knob full right until desired intensity is obtained.
- 3.9 Set peak volt dial to approx. 6 (this should produce a green trace (Horiz) six div. long).
- 3.10 Set circuit selector to base grounded position.
- 3.11 Position trace in extreme right center portion of screen.
- 3.12 Plug unit into test socket located inside of dry box.
- 3.13 Accept all units which do not cause the green Hor. trace to drop more than one division.

4.0 Quality

- 4.1 Equipment must be calibrated daily by Electronics Equipment Maintenance Group. (See Phil Campbell or Ashley Thomas).
- 4.2 All units which do not meet and requirements of step 3.13 and have been re-etched for a maximum of two times are to be rejected. These units are to be scrapped.

ECCO BOND (TF50-5)

1.0 Equipment

1. 1 Suitable stainless steel or aluminum storage trays
1. 2 Dry box (-20° F Max.)
1. 3 Tweezers Dumont 3C
1. 4 Finger cots
1. 5 Aluminum cup
1. 6 Magnifying glass with attached light (Fisher Scientific Co. #12-07101)
1. 7 Toothpicks

2.0 Material

2. 1 All units which have met the pretest requirements of TF50-4.
2. 2 Ecco Bond 26 (Emerson & Cuming Inc., Canton, Mass.)
2. 3 Bibulous Paper (Central Scientific Co. Boston, Mass. Cat. #66200)

3.0 Procedure

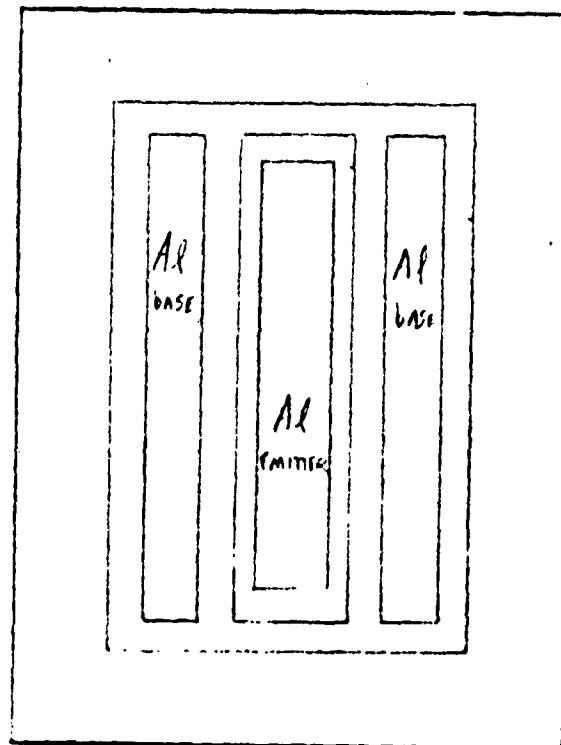
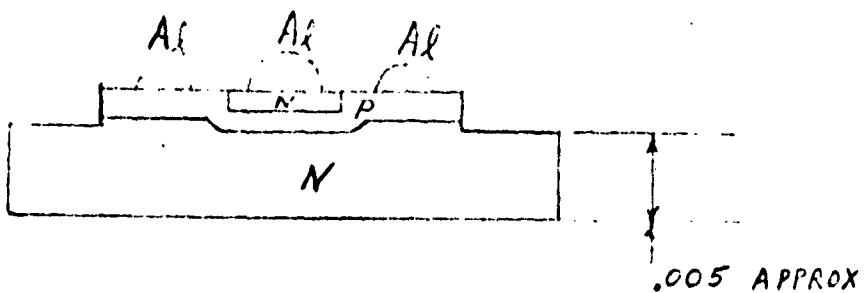
3. 1 Mix Ecco Bond in accordance with manufacturer's specifications.
3. 2 Apply a portion of this mixture between the header and base tab.
3. 3 Allow applied mixture to cure in a dry atmosphere for a minimum of eight (8) hours.

3. 4

4.0 Quality

4. 1 Reject all units that have excess Ecco Bond near or around the weld area (flange) of the header.
4. 2 Discard all adhesive that has not been used one-half (1/2) hour after being mixed.
4. 3 Operators must wear finger cots.
4. 4 Use only clean aluminum cups when mixing adhesive.

APPENDIX D

COPIES
TO

DIMS: .025 X .035 X .005

APPR'D	REVISIONS	LTR.	CN61-7138	TYPE: 2N696-2N697
ALL DIMENSIONS UNLESS OTHERWISE SPECIFIED ARE IN INCHES WITH TOLERANCES OF:			DRAWN DATE SCALE	
FRACTIONAL $\pm 1/64$			APPR'D DESIGN DATE	APPR'D PROD. DATE
DECIMAL $\pm .005$			1/27/66	
ANGULAR $\pm 1/2^\circ$	<input checked="" type="checkbox"/>		REV. LTR.	
TITLE: SILICON MESA PELLET			SIZE CODE	A314253P140

(PURCHASE SPECIFICATION (PR-142))

Material: Gold Wire

Diameter: 0.0010" ⁺ .0001 Note 1

Purity: 99.99% - 99.995% Note 2

Weight per units length of wire: 1.956 MGM per 20 CM ⁺ 5%

Minimum Break Load: 4 GMS. Note 3

Elongation Range: 3% - 8%

Spooling: Wind 200' (⁺ 25') on each of No. 5 spools.
The wire should be clean, free of grease,
dust or foreign particles.

Source of Supply: Sigmund Cohn Corporation

Either 121 So. Columbus Avenue
Mt. Vernon, New York

Or Secon Metals

For MID Purposes:

Note 1: Measured optically.

Note 2: A certificate of analysis should accompany lots on
a twice a year basis.

Note 3: MID to submit to the line a sample spool for a pull
test to determine the minimum break load. (And elongation
range).

HEADER MOUNTING (TD 43-2-P26)

1.0 Equipment

- 1.2 K and S Wafer bonder, Model 601
- 1.3 Special tweezers for mounting (Supplied with header mounter).
- 1.4 Tweezers
- 1.5 Clean 250 ML beaker

2.0 Material

- 2.1 Si pelleter TD43-2
- 2.2 Forming gas
- 2.3 Header per parts list
- 2.4 Preforms for TD (46-2) as per parts list. .5 mil thick, 35 mil dia., AuSb.

3.0 Safety

- 3.1 Refer to TST 31-19 for safety precautions.

4.0 Procedure

- 4.1 To turn equipment on:
 - 4.1.1 Turn power supply switch to "ON" position
 - 4.1.2 Turn control cabinet switch to "LIMIT" position.
 - 4.1.3 Plug in power-strip for accessory equipment (microscope lights, and vacuum pick-up pump with the 4-way electric valve system).
- 4.2 Adjust the forming gas flow rate
- 4.3 Turn slider rotation knob to the right and lock.
- 4.4 Sprinkle a small number (20-30) of gold preforms on the cap of the locating sliding stage. Replenish as necessary.
- 4.5 Sprinkle a small number of dice (20-30) on the cap of the locating sliding stage. Replenish as necessary.
- 4.6 Turn slider rotation knob to the left and lock.
- 4.7 Model 601-Depress Front tab. Insert header (emitter tab to right). Release tab and close cover.
- 4.8 Looking through the stereo microscope locate a gold preform on the cap of the locating gliding stage. Glide stage and bring the wafer directly below the tip of the needle of the vacuum pick-up.

HEADER MOUNTING (TD 43-2-P26) (Continued)

4. 9 Lower the Z action slider arm and bring the needle of the vacuum pick-up directly onto the center of the preform. Depress the "pick-up foot -switch" (left switch of double foot-switch)
4. 10 Raise the pick-up arm and transfer the preform onto the header by turning the slider rotation knob to the right and locking it in place.
4. 11 Lower the pick-up arm and center the preform onto moly pedestal on the header by adjusting the tubular micrometers on the back and the right side of the machine. (Once this adjustment is made no further adjustments are required for subsequent cycles).
4. 12 Release the "pick-up foot-switch" and depress the "release foot-switch" (right switch of double foot-switch).
4. 13 Raise the pick-up arm making certain that the preform is not displaced from its original position.
4. 14 Turn positioning knob to the left and lock.
4. 15 Looking through the steromicroscope, locate a die (stripes facing up) on the cap of the locating gliding stage. Glide the stage and bring the die directly below the tip of the needle of the vacuum pick-up.
4. 16 Rotate the gliding stage and align the stripes along the vertical axis of the field of view.
4. 17 Bring the needle of the vacuum pick-up directly onto the center of the silicon die. Depress the "pick-up foot-switch."
4. 18 Raise the pick-up needle and transfer the silicon die onto the header by turning the slider rotation knob to the right and locking it in place.
4. 19 Lower the pick-up needle and place the die squarely over the gold preform.
4. 20 Holding the pick-up needle down, apply pressure on the die.
4. 21 Release the "pick-up foot switch".
4. 22 Keeping one finger over the "press to stop bonding" button (red button) and looking through the microscope, observe carefully the die and wafer assembly.
4. 23 Within the next 3-5 sec. the bottom of the Si die starts to melt and goes into solution with the gold. A dark shiny area forms around the die and spreads radially away from the silicon.
4. 24 Model 601 - As soon as a fillet is found around the die, step on the cooling pedal. Do not release cooling pedal until package is removed from machine. Continue holding vacuum pick-up needle down until fillet freezes. (Time should not exceed 4 seconds).

HEADER MOUNTING (TD 43-2-P26) (Continued)

- 4.25 Wait until fillet freezes, then lift pick-up needle and inspect die for cracks and alloying through.
- 4.26 Turn the slider rotation knob to the left and lock in place.
- 4.27 Model 601 - Depress tab and take header from heater column.
- 4.28 Model 601 - Release cooling pedal
- 4.29 Place units in beakers and record number on counter.
- 4.30 Repeat steps 4.7 through 4.30 until all the units are mounted on headers.
- 4.31 To turn dice upside down -- pick up dice with vacuum pick-up needle. Lift needle slightly and release abruptly. Repeat until dice turn over. Use of tweezers is also permissible.
- 4.32 To turn equipment off:
 - 4.32.1 Turn power supply switch to "off" position.
 - 4.32.2 Turn control cabinet switch to "off" position.
 - 4.32.3 Unplug power strip for accessory equipment.
 - 4.32.4 Close the forming gas supply.

5.0 Quality

- 5.1 Each die should be placed symmetrically and squarely on pedestal of the header.
- 5.2 There should be a continuous fillet surrounding each die, covering a minimum of 75% of the dies periphery.
- 5.3 All four corners of each die should be touching the header.
- 5.4 Visible cracks on dice (under 50X magnification) are not acceptable.
- 5.5 Any units with gold alloyed through the surface of the mesa, or touching the mesa in any way should be rejected.
- 5.6 Do not touch the tops of the headers before or after mounting the dice.
- 5.7 Pressure on pickup needle to be 8 gm.
- 5.8 Refer to the flow chart for the appropriate process quality control specification.

THERMO-COMPRESSION BONDING OF LEADS (TD 43-2-P27)

1.0 Equipment

1.1 K and S Thermocompression Bonder (Model 400) with controls and accessories.

2.0 Material

2.1	Units per flow chart	2.5	Pipe cleaners
2.2	Forming gas		
2.3	Wire per parts list		
2.4	Methyl Alcohol, C. P. or Electronic Grade.		

3.0 Safety

3.1 Refer to TST 31-19 for safety precautions.

4.0 Procedure

4A. Procedure for Setting up Equipment

- 4A.1 Turn temperature control to "Auto".
- 4A.2 Adjust gas flow. Gas to be 95.5 N₂ - H₂. Gas to be passed through dryer (Hayes Molecular Sieve) and dew point to be -50° F or better
- 4A.3 Temperature to be calibrated each day. Bonders for pancake package to be set to 310° C.
- 4A.4 Bonding point to fix securely in vertical position in "V" groove of bonding tool holder. It must be free of "play". Point must not be chipped or damaged.
- 4A.5 Check the wire feeder for position (it must be capable of feeding wire to the unit within the limit of the joystick). Check the wire feeder by depressing the foot pedal and note the ability of it to feed.
- 4A.6 Adjust the position of the bonding lead so that each stripe can be bonded without Losing Focus. Set screws may be employed to secure motion. Magnification is to be between 2.5 and 3.0 on the zoomar microscope.
- 4A.7 All glare because of light source is to be removed by re-positioning the light source. Glare caused by reflection of light in the bonding wedge is not possible if wedge is positioned correctly.
- 4A.8 Bonding wedge is to be positioned so that the long axis of the wedge is parallel to the stripe. Wedge height and entire assembly height is to be adjusted so that application of pressure to a die will not result in a scrubbing motion.
- 4A.9 Machine is to be left on at all times.

THERMO COMPRESSION BONDING OF LEADS (TD43-2-P27) (Continued)

4B. Procedure for Bonding

- 4B. 1 Check to see that forming gas is flowing.
- 4B. 2 Turn light on
- 4B. 3 Adjust microscope to suitable setting with magnification between 7.5 and 3.0. Test the alignment by inserting a scrap unit and rotating the bonding head.
- 4B. 4 Use the special tweezers and load a transistor with the emitter tab to the left.
- 4B. 5 TF43-2 Rotate the bonding head to a position where the base post is to the right. Feed out wire across the base post to the left base stripe. Bond the left base stripe then the right base stripe and then the post. Break wire, rotate the bonding head and repeat the operation to bond the emitter stripe and emitter post. Again stagger the bonding to avoid shorting.
- 4B. 6 Remove unit from bonder and insert in a clean tray.
- 4B. 7 Repeat all operations until all the units are bonded.

5.0 Quality

5. 1 Units are not to be handled except with tweezers.
5. 2 Degrease tweezers four times per day.
5. 3 Use a small pipe cleaner and alcohol (methyl) to clean the bonding wedge four times per day
5. 4 Inspect the gas flow once per hour minimum.
5. 5 Store completed units in dry box.

AD _____	Accession No. _____	Unclassified	AD _____	Accession No. _____	Unclassified
Sylvania Semiconductor Div., Woburn, Mass. "MICROMINATURIZED PACKAGING OF 2N384 and 2N697" Final Rpt, 1 February 1962. Period 1 October 1960 to 1 February 1962 Contract DA-36-039-sc-85377 (Unclassified) 90p. p., including 40 illus., tables, charts. Prepared by: L. Epstein, C. Lawrenson, I. Feinberg, F. Bower.	1. "Microminaturized Packaging of 2N384 and 2N697" Final Report	Sylvania Semiconductor Div., Woburn Mass. "MICROMINATURIZED PACKAGING OF 2N384 and 2N697" Final Rpt, 1 February 1962. Period 1 October 1960 to 1 February 1962 Contract DA-36-039-sc-85377 (Unclassified) 90p. p., including 40 illus., tables, charts. Prepared by: L. Epstein, C. Lawrenson, I. Feinberg, F. Bower.	2. Contract DA-36-039-sc-85377	The purpose of this contract is to adapt germanium drift field and silicon mesa transistor junction structures and a micro miniature package such that hermetically (over)	1. "Microminaturized Packaging of 2N384 and 2N697" Final Rpt. 1 February 1962. Period 1 October 1960 to 1 February 1962 Contract DA-36-039-sc-85377 (Unclassified) 90 p. p., including 40 illus., tables, charts. Prepared by: L. Epstein, C. Lawrenson, I. Feinberg, F. Bower.
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